The Ideal World

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Changing the world our only way home

Content

Preface

Short- and long-term self interest drives us, and the ideal world lets our needs mesh. What do I want? and what do you want? are the questions the book digs into based on what science says we are like.

1 Behavioral sciences

Utopias have drawn on dividing labor, appealing to a benevolent creator, theorizing from economics, the empire of the efficient, technology, social justice and environmental concerns, a women-only world, a return to primitive roots and so forth.[I] They generally agree we need to build societies where seed potential blooms. Most visions, all the ones cited, have used fields of social studies, such as economics or politics, to ground their ideas. As we lack a hard science basis to analyzing behavior of social groups, statistics and past behavior have guided the ideas, making them theories tested only by putting them into practice, their chief curse that cost.

Because societies are made of people, one could start at the other end, analyze basic traits of individuals, and then see how they blend or clash. The behavioral sciences have progressed far in this, with the details under debate, but the outline clear. The latest branches—EP (Evolutionary Psychology), behavioral genetics, neuroscience—agree minds mix preferences, possibilities and pitfalls. Evolutionary psychology sees the brain as made of processing modules, each taking a set of inputs, which includes social input, with a behavior as output. These modules are also calibrated by what we see as children. Behavioral genetics shows genes decide our dispositions, channeled then by the environment.

The basic wants of hunger, thirst, sex, sleep, emptying bowel and bladder when full, and resting when tired, can be analyzed with anatomy, biochemistry and neuroscience. The psychological mechanisms can be understood with EP, behavioral genetics and neuroscience. Why these tools? They are the ones academia sees as promising. As we will see, all these fields have grown in the last few decades, and are the leading scientific candidates to explain behavior. For a vision built on analytical sciences, one can be more confident the gap between word and deed can be bridged.

Scientists have analyzed behavior at many levels. Some are more useful than others for separating how genes and the environment influence how we behave. At the top level is evolutionary theory, specifically natural selection operating on genetic mutation and drift. At the next level is EP, which explains how evolution applies specifically to human behavior. Behavioral genetics, and psychiatric genetics which is a part of it, detail how genetics and the environment influence human behavior. At the lowest level is the study of how our brain works: its structure, neuroanatomy, and its chemical behavior, neurochemistry. To support arguments, all these sciences try comparing humans to animals where the analogy is expected to hold. Evolutionary psychology often draws on cross cultural and historical studies to show traits or dispositions are innate.

1.1 Evolving life

Darwin's originally stated theory of evolution was that species arose from changes passed to future generations being selectively weeded out by sexual selection, primarily by females, and natural selection. Some set of changes were preferred because those with it survived better and reproduced more, and hence the proportion carrying it rose in the population. As changes stacked up the nature of the group changed, and it eventually evolved into a new species, in the process of speciation. The original theory was hence of natural selection favoring changes which make one reproductively fitter, with enough cumulative changes leading to a new species. Sexual selection can be thought of as part of natural selection. Darwin's ideas of how changes arose was not integral to the theory, and has by now been dropped.

In the mid 20th century, genetics helped explain how changes arise and how they are passed on. The DNA molecule, the genome, encodes the information to build an organism, and specific parts called genes act as the units of heredity. Genes are packaged inside longer molecules called chromosomes. Both genes and chromosomes change in several ways, either spontaneously (randomly), induced, or, more controversially and less frequently, adaptively. Random mutations are changes in genes not caused directly by external elements. Induced mutations are those forced by outside agents such as radiation, or chemical exposure. Adaptive mutations are genes changing to adapt to the environment. These are rare and disputed.

A trait nature selects is called an adaptive trait. Since natural selection works at the level of genomes of organisms, often some corollary genes, and hence traits, also end up selected along with the adaptive trait. Such traits are called byproducts. Other changes which get passed on because they are neutral are called noise. Selection can be directional, directed toward one extreme or the other, say shorter beaks or longer beaks in birds. It can be stabilizing, favoring the average trait or phenotype, say an average-length beak. It can also be disruptive, choosing the extremes and weeding out the average, say both longer and shorter beaks but not average-sized ones. Disruptive selection over a period of time can lead to new species unable or unwilling to mate outside their group. Technically, two daughter species forming from a parent one is speciation, or cladogenesis, and a species changing into a new one is phyletic evolution, anagenesis.

Natural selection can act complicatedly and non-intuitively, but its primary mechanism is one of reproducing in different numbers: those with a particular set of traits begetting more and passing on the genes for the trait to offspring. Migration and population flow also change the gene pool of population groups, adding to random mutation.

So what is complicated about this? This simple model implies many things. For one, natural selection does not work on genes, it works on traits. Most traits are from multiple genes. Selection selects favorable combinations of genes. Selection is not just for the next generation either. Thus a trait that makes one have fewer children, but allows those children to be fitter and have more grandchildren, can pass through the filter. An example is longer life, well beyond the point where one can sire kids. This helps one take better care of grand and great-grand children and help them survive better. Selection ultimately favors traits which lead to a larger number of final descendants, not just more sons and daughters. It is commonly presented as favoring the reproductively fit, that is those begetting more children, since that approximates the real world closely enough.

In its original from, put together separately by Darwin and Wallace, natural selection was thought to work within populations competing for resources. They assumed resources were sufficient only to support a limited population, and hence members competed for scarce resources and only some survived to reproduce. This culling was termed the struggle to survive, though reproducing, not surviving, directs selection. Fundamentally, selection does not need to depend on resources being scarce. A trait that causes a person to be sterile, for example, will be selected against even if resources are abundant.

The other force driving evolution is genetic drift. The DNA molecule is made up roughly of a few dozen chromosomes, and each chromosome exists in two pairs. Each gene has two copies, or versions, one each in the two chromosome pairs. If the versions, technically the alleles, are the same, the locus is homozygous, else it is heterozygous. If no mutation or selection happens, over a long enough period, in any population all genes will end up homozygous. This is genetic drift toward homozygosity. The second form of drift fixes alleles across individuals. If three alleles A1, A2 and A3 of a gene exist, after every generation, the proportion of the alleles will change at least slightly. Given enough time, the entire population will end up with the same version, which could be any one of the three. The probability theory behind these non-intuitive outcomes is explained in detail in Appendix A on page 349.

Kinship selection is a mechanism by which a gene which makes an individual reproductively less fit still gets passed on because it makes the kin group more fit. For the gene to be passed on, how less fit a person becomes must be outweighed by how more fit the extended family gets to be, the second weighted by the chance the same gene exists in the extended family.[2] Kinship selection is also known as inclusive fitness since it includes kin influencing how reproductively fit the gene pool is. In effect, how reproductively fit individual genes are is what matters. Replication fitness would be more accurate.

The current theory of evolution is hence one of: natural selection, on inclusive reproductive fitness, working on random genetic and chromosomal mutations, to produce adaptations, byproducts and noise. To analyze changes, one also needs to account for genetic drift, which with mutations and selection absent, would lead to some changes becoming fixed in the population. Evolution has succeeded in explaining much behavior in the realm of life, with a unified theory. One could say it sacrifices precision in the case of gene changes, substituting a random distribution for a deterministic or probabilistic one. Natural selection too is a different way of analyzing a process influenced deterministically by the environment, and hence with its outcome fixed. But removing the nonessential to obtain simpler analyzable models is likely a part of most scientific theories.

1.2 Mutating randomly

Why are mutations called random? In Darwin's time, genes were unknown and his original theory assumed inherited traits of children were physically blending the parent's traits. The result would be any variance in a trait in a population would diminish fast (by half every generation, if one works out the math). For natural selection to have a pool of differences to work on, new differences or mutations need to arise often in every generation. In addition, these changes have to be biased toward fitness, since others, weeded out by natural selection, will not count. In effect, the mutations would direct the nature of evolution. Fisher, in his *The Genetical Theory of Natural Selection*, devotes his first chapter to examining this. When it was discovered inheriting, driven by genes, is discrete with no blending, mutations no longer had to be purposeful. Discrete mixing largely preserves variance. Experiments also suggested germ-line (the cell line leading to sperms and eggs) mutations were not driven by fitness requirements. The adjective random, as applied to mutation, emphasizes this difference; mutations are not directed or goal-driven. From a natural selection perspective, mutations do not aid selection. Where aim is defined as what natural selection achieves, filtering the replicatively less fit genes, mutation is aimless.

Random mutations are not mathematically, statistically, random. In math, a random sequence is one for which no probability distribution can be specified. I will cover this in more detail in section 15.1.2.1 on page 298. Biologists view mutations as random since it is a convenient way to analyze them. Mutations are physical processes and hence follow physics laws. There are exact, deterministic rules which govern when and where nucleotide sequences change in a cell's DNA. These rules are complex, and our science is not at a stage where simpler models capturing the essence exist. It is not clear whether such are possible. So biologists explain the mechanism as random. It is so only at the abstraction level of cell chemistry; not as per the laws of physics.

1.3 Evolutionary psychology

This section will draw on the seminal works of the founders of EP: R. A. Fisher, William D. Hamilton, George C. Williams, John Maynard Smith, Robert Trivers, Richard Dawkins, Donald Symons, Martin Daly, Margo Wilson, John Tooby, Leda Cosmides, and David Buss.[3] I will base my analysis on their books, and the papers referred to in them. Since the field is fast moving, I may miss some recent discoveries, but EP is a field where results can be considered final only after they have been replicated, and allowed to solidify for a few years.

1.3.1 Adaptations

Evolutionary psychology describes the human mind originating from natural selection in the past. It assumes the brain has many modules, each of which arose as an evolutionary adaptation in response to selection pressures of our ancestral past, the EEA (Environment of Evolutionary Adaptedness). For humans this is the Pleistocene period, between 1.8 million and 10,000 years ago, when our ancestors were hunter gatherers on the African savannah. This is called the massive modularity hypothesis. This needs to be contrasted with other psychology theories which assume the brain is a general purpose learning machine, able to do various things based on what it learns. Most of EP is about how to identify the traits as they existed in the EEA, and coming up with hypotheses to explain how they arose. This field considers societies a product of our traits, not the other way around. It assumes culture flows from our attitudes and behavior, both dictated at least partly by our biology. It hence assumes cultural influence can be ignored, and identifying hardwiring in the adult brain is good enough to consider a trait an adaptation.

1.3.1.1 The definition

For EP, adaptations are processing modules in the brain designed to generate a single behavior. Largely they are subconscious in that they are not driven by conscious reasoning. There are strict criteria for a trait to be an adaptation.[4] First, it must be genetically based. In practice, hardwiring in the adult brain is considered to prove this. Second, it must have had a function in the EEA which it did well. The last part might seem overly restrictive, since selection crafts adaptations gradually, getting them to be fully functional only at the end. However, evolution is also thought to work in fits and starts, with long periods of equilibrium, punctuated by a short burst of change. Short in geological time frames, but not a biological one. Punctuated equilibrium, as its author Stephen Jay Gould called it, means if you pick a random species and a random time period, it is likely not evolving majorly. Adaptations are probably final. The third characteristic of an adaptation is it be species typical. Most humans should have it, across countries and cultures. Evolutionary psychologists emphasize cross-cultural studies.

The brain modules which EP identifies are processing modules. They do not generate behavior in a vacuum. They produce an output, an expressed behavior, only with a specific set of inputs, the environment and experiences combined. If the specific input which activates them is absent, they lie dormant. A module that hardwires sexual jealousy in a heterosexual man can activate only if he observes his female mate flirting with another man, or if he observes a female he has no sexual access to. For a world to be ideal, this input needs to be blocked. Contexts which can trigger jealousy should vanish.

1.3.2 Calibration

The processing modules are also expected to have knobs set by the environment. They are likely calibrated by experience, particularly in the formative years. See figure 1.1 on the following page. For the jealousy example, an understanding, instilled in childhood, of how and when women desert a man, is one such calibration.

1.3.3 Overrides

The modules can be overridden by the conscious brain, part of the neocortex, with its own cognitive adaptations. In our worlds we exercise the override frequently. Our societies are built on exploiting this mechanism.

1.3.4 Triggers

Unlike the popular meaning of innate nature, the behavioral mechanisms of EP are not self-driven modules which force us to be a certain way. They are processing modules, calibrated by learning during childhood and later, and activated by specific inputs. How psychology once defined instinct, as something which if suppressed eventually erupts spontaneously, does not accord with how

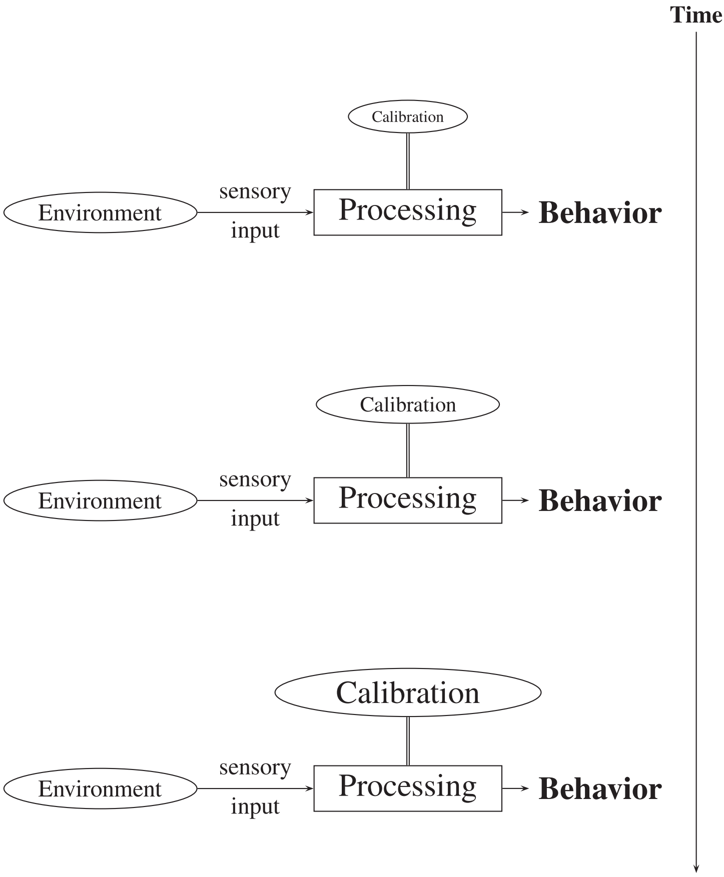


Figure 1.1: Growth during childhood of an adaptation module

EP defines a psychological adaptation.

Understanding us hence becomes more than understanding the psychological adaptations we have. It also means understanding how and when they arose, so we can be reasonably sure how the mechanism would work if calibrated differently or without a triggering input. We are not talking of overriding negative mechanisms with conscious effort, that is of suppressing the adaptation, something which empirically is known to fail often. We are instead looking at how to avoid triggering it at all in a transitional world, and deactivating its calibration for further generations brought up in the ideal world.

1.3.5 Theories in EP

Practically, the theories of EP exist at two levels, below the general theory of evolution.[5] The middle level consists of theories not derivable from evolution theory, but adding to it. The three main ones are the parasite-host coevolution theory of Hamilton, Parental Investment theory of Trivers, and the Reciprocal Altruism theory, again from Trivers. Below these are specific hypotheses which explain individual traits such as sexual jealousy or sexual choice.

1.3.5.1 Parasite-host coevolution

Hamilton was one of the early proponents of the parasite and host coevolution theory, specifically explaining how sexual reproduction could arise. After all, asexual reproduction (cloning) passes 100% of genes from parent to offspring, and would be preferred to a mode which passes only 50% of genes. The theory, the Red Queen theory, states sexual reproduction arose to diversify genes to deal with parasites such as bacteria and viruses. These organisms multiply and mutate fast, and so others had to shuffle genes every generation to be able to throw them off. This favored sexual reproduction involving two members of a species. The general parasite host coevolution theory states there is an arms race between parasites and their hosts in genetic selection. Parasites change genetically, by natural selection, more ably attacking hosts. Hosts counteradapt, changing again by selection, to block this. There is no equilibrium; the changes on both sides are continuous and sometimes oscillatory.

Neither hosts nor parasites change with a purpose in mind. Natural selection is not a mechanism with an aim; it is a natural sieve which lets through different changes at different rates. Because of the way it works, the end result will look as if parasites and hosts are coevolving trying to outwit one another. Not many psychological mechanisms have probably arisen through coevolution; most such are physical in nature. The immune system is an example.

1.3.5.2 Parental investment

In humans, women invest more in their children in resources. A female has fewer eggs than a male has sperm, and eggs, being bigger, cost more food to produce. Females have to carry a baby to term, and typically breastfeed it after birth. And in all cultures the mother is primarily responsible for child care.

The theory of parental investment states the sex that invests more in offspring will mate more selectively. The other sex will compete more for sexual access to the high investing sex. In humans, that means females will be choosier about sex, and men more competitive about it.[6] Mating preferences, and hence the sex drive, of both men and women have to flow from this general theory.

1.3.5.3 Reciprocal altruism

Reciprocal altruism extends kin selection to total strangers. An individual may help a genetically unrelated stranger, expecting the favor to be paid back immediately or later.[7] The better the memory power of the species, the longer the duration can be between the favor and it being returned. There is one crucial difference in extending from kin selection—in kin selection we further our kin's survival. In reciprocal altruism, we impress on somebody we have done them a favor to get a benefit back. The favor can be real or concocted to look real. This makes the mechanism complex, since others are going to evolve ways to detect the difference. Leading to an equilibrium state. Kinship selection, being directly associated with survival of kin, is less complex. The altruism theory can explain a broad range of behavior, but cannot be tested directly.

1.3.5.4 Sexually antagonistic selection

Sexually antagonistic selection is similar to the parasite-host coevolution theory, except the arms race is between the sexes. The male tries to make sure matings lead to offspring, even at the expense of the female's survival. The females then counteradapt as a defense. Males change genetically to bypass these defenses. This is another continuous unstable situation. The two sexes never become perfectly adapted to each other in how they mate and reproduce.

Specifically, parental investment clashes and mating rate clashes may happen. The parental investment clash is the clash between men's liking for short-term flings, and women's for long-term bonds. Men are adapted to mate and leave. Women have response adaptations to these, such as mating preferences which select only those men likely to stay. The rate clash is from men wanting more sex, since their energy investment of just sperm is low.

Humans do not have a mating rate mismatch (as an example, a clash happens in fruit flies because the sperm is slightly poisonous to the female). There is a parental investment clash, and we need to make sure it does not activate in the ideal world. Having everybody and not just the parents responsible for kids ensures this. Parental investment ceases to exist with group upbringing. It is the practical way to get beyond parental investment, and the mating clash which comes with it, that is men wanting to mate free, and women wanting to tie sex to settling down. Just parents bringing up their children implies a family system where men and women are tied to one another, against the adaptation which produces the Coolidge effect, where males fail to be aroused by the same female after a period, but are roused by novel ones. Or, for that matter, against the adaptation that gets us to explore and check out novel settings.

1.3.6 Traits which help us survive

Humans who lived in the Pleistocene hunted, gathered plants, nuts and roots, and opportunistically scavenged other food. Mostly men would have hunted. Food shortages, poisonous food, predators, diseases and climate extremes would have plagued them. Both men and women. Evolutionary psychology posits humans would have adapted to deal with these. Most adaptations would be biological in nature, and a few psychological, in the way these words are commonly used. Accurately, a few would be related to the central nervous system, and most to other systems.

Our behavior has evolved:

· To prefer some food, specifically calorie rich food such as sugar

and fats.
- To avoid toxic food by feeling disgust at rotting odors, and disliking a bitter taste. These are psychological in nature. Biological mechanisms for avoiding toxic food include gagging (removal from the throat), spitting (from the mouth), vomiting (from the stomach), coughing (from the lungs), sneezing (expelling from the respiratory tract), diarrhea (removal from the intestines) and pregnancy sickness (protecting the early foetus by expelling toxins not poisonous for an adult).
- To like landscapes which resemble the savanna. Tall trees, evenly spaced with a canopy but no thick undergrowth, where one can watch without being seen. Our liking for camping and hikes probably flows from this.
- To fear snakes, spiders, heights and strangers.
- To combat diseases. There are adapations which help the body get rid of germs, such as fever, allergies with their attendant coughing, sneezing, low blood pressure and even iron-poor blood [FIX]. These are biological adaptations, not psychological.

1.3.7 Making us reproductively fit: mate guarding

In many species males guard females they mate with, especially during their fertile time. This ensures the children tend to be the male's, passing its genes on. The time spent on guarding is time lost on mating with other females. Hence there is a plus and a minus to it for reproducing. We will look at how an ideal world would handle the mate guarding trait, after covering the human sex want.

1.3.8 Making us reproductively fit: mating preferences

Evolutionary psychology does not consider the male and female drives identical. The parental investment theory implies the opposite. In general, men are predicted to have an indiscriminating, mostly physical, drive, and women a choosy one subject more to learned control. Note that in this field, the word innate covers psychological mechanisms.

Male sex drive preferences are weak, with a near universal liking for women. There is near consensus on this. Everything from folklore, historical records, the word on the street, biology, anatomy, and psychology, both evolutionary and otherwise, agree. Men do prefer women more likely to be fertile, younger women with neotenic features such as large eyes, small nose, chubby cheeks, smooth skin, low waist to hip ratio, and signalling easy sexual access. Mating preferences can be either long term or short term. Long term preferences have to do with finding a mate to raise children. For men the preferences are about the same as the short-term ones. I will cover short-term preferences of women next.

1.3.8.1 Short-term mating preferences of women

An evolutionary perspective looks at ultimate causes, ignoring proximate ones. Proximate causes explain behavior directly, while ultimate causes explain why that behavior sprung up. The proximate cause of sex is the pleasure, while its ultimate cause is passing genes on. EP scientists have also looked at self-reported preferences, though these are not expected to correspond as is to preferences which are adaptations, since the cortical modules involved in EP preferences often are not conscious ones. We are not aware of these modules working in the background.

Women are expected to prefer, short-term, men who can leave behind better genes for offspring. They are expected to prefer men who can provide them resources such as gifts, dinners, rented apartments, and free leisure trips (the resource acquisition theory). A preferred short-term partner has to be physically attractive, have resources (primarily money), and be lavish.

Resource acquisition is a trait evolutionists believe has been selected for since it makes us fitter. There is no brain hardwiring for any specific possession, gifts or money. But there is a generic resource acquisition module, which takes its cue, as to the exact nature of the resource, from the social environment. In a society where everything is shared, the resource acquisition module will be dormant.

There is the secondary question of when women prefer to mate short term. One possibility is when they decide to switch mates (mate switching), or to prepare themselves for a later long-term dalliance. Mate switching is when women engage in short-term mating when trying to break up with a long-term partner. Women, especially adolescents, may also engage in short-term mating to learn and prepare for later long-term mating.

Self-reported motivation by women for short-term affairs corresponds closely to what theory predicts they prefer and are motivated by. The primary additional incentive is sex pleasure, but from an evolutionary perspective this is a proximal cause, not an ultimate one. All pleasures would have evolved for a reason, and EP does not consider pleasure the motivatory origin of any behavior.

Which brings us to the evolutionary explanation for the origin of the female orgasm. The two main theories are that it is a byproduct of the male orgasm, and that it is an adaptation which improves sperm retention in women. The adaptation theory has been challenged, most recently by Lloyd. That female orgasm is not species typical, and that its widespread presence in other primates is far from certain, both argue against the adaptationist stance. The evidence for sperm retention is thin, with the earliest and most extensive study, of M&J, showing orgasm was likely to cause sperm to be expelled. The byproduct theory comes from one of the pioneers of EP, Symons, supported by Gould and recently by Lloyd.

Physical attractiveness is measured with a host of phenotypic features. Phenotypic condition shows how efficiently an individual can acquire resources. Smooth skin, rich hair, good teeth, symmetric movements, symmetric face and body, tallness, large size, optimum body mass index, and upper body strength, specifically broad chests and shoulders, are all male physical features which women prefer. These are tied to the better genes for offspring theory, and tend to be what one intuitively expects. One could argue they are culturally learned. An evolutionary psychologist would respond that since the preferences are mostly consistent across cultures, one needs to look at why most cultures teach women the same things. Their answer is the teaching accords with the basic innate trait. There is some evidence women prefer the scent of symmetrical men but these studies do not represent the real world. Women are asked to smell a T-shirt worn for several days by a man, thereby concentrating his body odor. In the real world, mating pairs get to smell each other for the few minutes they are together; they do not get to amplify body odor to attract a mate.

Women show slight differences in how strong their preference is, across the menstrual cycle. However they do not change the rate at which they have sex significantly. The fertile phase of the cycle only amplifies the preference already there. Whether their desire for sex increases is unclear, with contradictory results from studies. This desire cannot easily be split into an innate and a learned version. Hormones affect learned desires, addictions, as well.

Cross cultural studies show the weights for each attractiveness trait varying widely. There is no specific hardwiring module for these weights. All psychological adaptations are expected to process local social cues to generate the cultural differences found in attractiveness standards. The actual traits women see as physically attractive would be those they have learned make a man fitter. The learning would be cultural in nature, though preferring the fit would not be. Note that evolutionary psychologists control for race in most experiments, that is they ensure the subjects are of the same group. The learned liking for faces of the same race by three-month olds but not newborns, shown by many researchers,[8] shows how deeply society influences what we prefer. Symmetry seems to be innately preferred, not culturally learned. This area of EP is not well-defined, since surveying what adults prefer often just tells us the obvious.

Short-term mating is decided on consciously, and tied to reproduction and all it implies. Even in this contraceptive age, this holds true. Women on pills do not show the same mating preference. Which incidentally tells us the preference is not conscious. Those not on pills need to look at a different set of traits, say a cooperative nature, to be sure the man uses contraception. Note that preferences are not a drive. They are a mechanism to choose people, not one driving a person to another. Women who see physically attractive men do not feel a mating urge; there is plenty of research showing women do not respond much to visual stimuli.[9]

1.3.9 Traits helping us live in groups

Humans, like most other primates, form groups. The size of those groups varies. Animals and birds also form groups, and the optimal size varies for each species. Group living requires an individual to cooperate with others.

1.3.9.1 Cooperation

Evolutionary psychologists use reciprocal altruism to explain cooperation. It is equivalent to the "gain in trade" of economics; each party receives more in return than it costs to deliver the benefit.

The effects of such reciprocity, unlike kin selection, are not easily mathematically tractable. Scientists use game theory to analyze this. The common example game used is the prisoner's dilemma. Think of two people thrown in prison for a crime they have committed together. They are held separately and not allowed to talk to each other, and questioned separately. If both prisoners confess (cooperate) then they will both get a jail sentence of 4 years. If one confesses and the other does not, the 'rat' gets off free, while the other gets a stiff sentence of 10 years. If neither confesses, both get a sentence of 1 year.

The rational strategy is for both to confess. If A confesses, on average, he gets a sentence of 2 years (0 if B holds back, and 4 if B confesses). If A holds back, on average, he gets a sentence of 5.5 years (1 year if B holds back, and 10 if B confesses). Rationally A should confess, and expect an average sentence of 2 years. The optimal strategy is different. Both A and B should hold back, and take a sentence of 1 year. With no past information on what B is like, A would confess.

Cooperation shows up in an 'iterated prisoner's dilemma' game where this game is played over and over for an unspecified number of rounds. Prisoners can use what they learn from previous rounds to decide how to behave. Axelrod and Hamilton simulated this with a computer tournament. Various programs using various schemes played against one another. The winning strategy was one called *tit for tat*. This program always withheld on the first round, and afterward did whatever the other did previously. It started withholding, and then reciprocated its partners moves. If the partner ratted on the last round, so did the program; if the partner had held back, it did likewise. Holding a grudge, but a short-term one not carried across more than a move.

While *tit for tat* did win, and while strategies which were nice to their partner but held grudges in general did well, it is not clear how true this is of the real world. Natural selection would have favored a *tit for tat* strategy if nature had the same mix of strategies seen in the tournament. This would be one way cooperation would have evolved. Limited cooperative strategies can often win over pure greed.

A strategy such as *tit for tat* is said to be evolutionarily stable if it can come to dominate a population starting from scratch, and if, once established, it is hard to dislodge. An ESS (evolutionarily stable strategy) can be preferred by natural selection, and become an adaptation. Alliances, friendships, and social mixing, are all explained in the standard model in terms of ESS.

Reciprocal altruism is not an unmixed blessing. It implies we can calculate costs and benefits of exchanges. Evolution would then favor subconscious cheating in the accounting, say by remembering favors owed us better than favors we owe. And probably an even more direct kind, trying to grab a benefit and run somewhere else, socially. In return, people would evolve adaptations to detect cheaters. And other adaptations to at least appear fair, since there is a fitness value to it in terms of social status. Our final behavior will result from these mechanisms pushing and pulling, concertedly or conflictingly. Evolutionary psychology is of no help in predicting behavior, since we have a range of mechanisms which mix myriadly.

That digression aside, note that reciprocity assumes the ability to detect cheaters, and to evaluate the costs and benefits of a variety of items of exchange. In the modern world, money simplifies the second. How to calculate the cost and benefit is external, and learned from the environment.

Tooby and Cosmides have an additional explanation for the evolution of friendship. After all, people do get pleasure from helping others even when the help is not returned. Insisting on immediately repaying help is considered being aloof. One way to explain this is to rethink what altruism is. It is commonly defined as an act which costs one but benefits another. Human behavior does not have to be zero sum. There are actions which do not cost one but benefit another. These do not need a reciprocity theory to explain.

1.3.10 Unifying evolutionary psychology

Evolutionary psychology as described above is mostly social psychology. The approach has also been extended to cognition, that is to how we reason and feel self-aware. In this domain, evolutionary theory predicts humans would have specialized abilities to reason, depending on the type of the adaptive problem they were selected to solve. Prior theories suggested humans have general abilities to learn, imitate, calculate means-ends relationships, compute similarity, form concepts, remember things, and compute representativeness. Evolutionary psychology suggests instead the mind is filled with complex and problem-specific processing mechanisms, calibrated by experience during childhood, and taking the environment as its input. In the ancestral environment, visual input would have dominated, followed by verbal language for a shorter evolutionary period, and then written input. As a result, we are predicted to be able to digest visual input, say charts or graphs, faster than the same data in verbal form. This is tentative since an alternate explanation exists: written information is more compact than charts and graphs, and being informationally dense needs more parsing and analyzing.

Some predictions of this theory have been shown true by empirical research: men are better at map reading and maze learning, both useful to the ancient hunters, mostly men. Women are better at spatial tasks involving where things are (location memory) and what is at a place (object memory), skills required for their gathering role of the past.

Individuals may have adaptations for different strategies, say short-term and long-term mating. Which strategy eventually dominates in an adult could depend on developmental experiences. A father's absence, for example, pushes an offspring toward riskier strategies, and they develop an extraverted and impulsive personality as a side effect. This calibration of adaptive modules by experience, will lead to behavior differing individually. The adaptations of EP are hence developmentally flexible, calibrated by the rearing environment.

Evolutionary personality psychology tries to absorb individual differences into the broader framework. Natural selection, specifically directional selection, tends to narrow individual differences and force a species to be uniform. The main theory of how individual differences can remain is the frequency dependent theory. Note not all genes get fixed by drift to one allele. After all, most higher-order species have two sexes, in about equal ratios. This means the sex-determining gene stays at a minimum of two alleles and does not get fixed to one. When the sex ratio goes to 0.55, say, the pull toward 0.5 is stronger than the pull toward 0.6. This will cause the ratio to oscillate around the 0.5 value. Two strategies driven by different alleles can be in frequency-dependent selection equilibrium if their payoffs are inversely related to the allele frequencies. As the frequency of one strategy decreases, its payoff increases, bolstering it and re-establishing the equilibrium. Linda Mealy suggests psychopathy is maintained this way.

1.3.11 Summary

Evolutionary psychology looks at traits which arose in the EEA, the Pleistocene. Those traits may or may not lead to the same behavior in today's societies. They should not lead to the same behavior in the environment of any ideal world. In some cases, the traits can lay dormant (and possibly eventually disappear), since the environmental input which activates them can be cut off. In others, their expression can be modified or suppressed, since the route from trait to expressed behavior passes through the environmental and experience modules. The core issue is whether the ideal world will slip because the innate wiring pushes us to behavior incompatible with its tenets. Such traits, competition, jealousy, aggressiveness and so on, will be covered in later chapters. Evolutionary psychology is just one tool I will use to look at what the likely result of our innate wiring for the subtraits would be in the ideal world. Since no experimental results are available, I will use the mass of evidence from different branches of science, EP, behavioral genetics and neurochemistry, to build the ideas founding the ideal world. The sociological fields, anthropology, sociology, criminology and the like, are not relevant or useful here since they assume the environment primarily shapes behavior.

One needs to carefully parse the nature of adaptations to see how negative ones can be made dormant. Or, more precisely, how a subset can be environmentally deactivated so the remaining can mesh to form an ideal world. Just showing the environment in which an adaptation arose no longer exists in the ideal world is not enough. This does not idle an EP adaptation. The crucial part is blocking the environmental input, and adjusting the developmental calibration. The reasons why the adaptation rose are not material; more important are the reasons it gets triggered. In many cases the two reasons match, but we cannot take that for granted.

An example is liking for fatty food. This arose in the EEA responding to the need to store fat in a world where food could get scarce frequently. Food preferences are set in childhood. So children in the EEA developed a liking for fatty food, the developmental calibration. The preference does not vanish in a world where food is available in plenty. The adaptation is not related to children sitting, thinking and deciding eating fatty food is good because we are not sure we can get such food in the next season, and it is better to store fat in our bodies now. The adaptation is a subconscious one. It can be blocked, either by building a world where fatty food is not widely available, taking away the environmental trigger, or where we are brought up seeing and imitating others eating non fatty food—the developmental calibration.

Second, though EP adaptations rose logically responding to the EEA conditions, they are not conscious, reasoned, behavior. The modules are subconscious. An ideal world cannot ask people to think and that way get beyond behavior inimical to its tenets. Well, it can, but that is a weaker glue. The stronger binding is to make sure people do not have to use conscious, rational thinking to adhere to social tenets. They should feel committed pressed by those subconscious adaptations the ideal society triggers.

Note that all subconscious behaviors are not EP adaptations or even necessarily innate. Showing a mechanism is subconscious is hence not enough to make it an adaptation, an innate wiring. A large amount of subconscious behavior is learned. Riding a bicycle, for example is controlled largely by the cerebellum and the basal ganglia once the skill is learned. These brain structures are evolutionarily as old as vertebrates, animals with a backbone. They have to be classified as subconscious in common parlance; neuroscience itself does not use this word much. Most forms of motor learning, and conditioned, that is learned, fears reside in the subconscious brain, the last in the amygdala. Innate and learned do not map to subconscious and conscious in either direction. This point is underemphasized by popular science texts,[10], since it leaves a large number of hypotheses in EP, especially related to general social behavior, still as formative theories, not established facts. One could write a book based on such theories, but not build a world assuming they are true. Or that they are false. The ideal world should hold for both cases.

Third, societies cannot change in quantum leaps. From our world to the ideal one there has to be a continuous path. While transitional societies cannot be ideal, we need to be sure they progress steadily toward it, and do not regress. The main difference between transitional societies and the ideal one is in the calibration of the EP adaptations. Our calibrations are mostly set. Unlike the child of the ideal future.

Fourth, EP is a field rich in speculation. Take the theories in the populist book by Wright.[11] Wright posits adaptations for both pride, self-aggrandizement, and humility, self-deflation. The science does not consider either established fact. If they indeed are, one is left confused as to how to usefully apply the theory. If everything we do, and can possibly do, is an adaptation, is there a point to the science? Clearly, as the field progresses, the theories will be winnowed down to a few consistent ones, explaining a range of expected behavior more consistently. But we are not there. There is the hypothesis that our behavior depends on ESS, where the various competing strategies are evaluated in interactions and an equilibrium is reached based on how others respond (the tit-for-tat or similar strategies mentioned earlier). This entire process, which mimics the conscious reasoning we do when explicitly debating how to proceed, could have been subconsciously developed by natural selection. This mechanism too depends on environmental input, including how others behave with us, and calibration, both while growing up, and later. And it is still a hypothesis; the details are unlikely to be as simple as the tit-for-tat strategy.

The adaptations of EP, connected across people to represent their interactions, represent pieces of a jigsaw puzzle. Unlike standard puzzles, this one has multiple solutions since the pieces can fit together many different ways to produce a final picture. Our current social mores and interaction modes are one such picture. It is not the only possible picture the same adaptations can produce. If one looks at reciprocal altruism and all the adaptations which flow from it, clearly the push and pull of the competing mechanisms—cheating, detecting cheating, feeling a victim, a need to punish, a need to be fair—can lead to many different kinds of societies depending on what gets emphasized during childhood learning and later. Conscious awareness can change the strength of each mechanism, by changing the environment around us. This assumes, like every other statement about societies does, that we have free will. While popular science thinks we have no free will since everything is biologically determined, even if not directly genetically decided, I will show in Chapter **??** on page ?? how free will can exist even when we are fully the products of chemistry and physics.

One particular adaptation, the conscious awareness which allows us to change our societies, allows us to put together the puzzle pieces in differing ways. The puzzle pieces form a self-aware entity able to self arrange. This has happened in the past; societies have changed in several ways, rearranging the adaptation interactions to form new jigsaw pictures. This is why how the pieces come together to form our current picture, the current social setups, as described speculatively by some authors,[12] turns out to be not relevant for the ideal world. The take here is that EP, behavioral genetics and neuroscience have correctly identified many of the pieces, and how they are put together today. This books is about how those same pieces can be put together a different way to get an ideal world. This means we need to understand the pieces and in what ways they jell or merge with one another.

So the ideas here will look at only those adaptations EP considers solid, the ones in the textbooks and handbooks, not those in popular science ones. Examples are sex preferences, jealousy and the like. I will show why other detailed social psychological aspects do not matter to us. Whether self-deception is an adaptation is immaterial where its triggering input and calibration are guaranteed to be absent. If it is an adaptation, it will not be active; if it is not, if it is a product of conscious reasoning, then people will have no reason to employ it. If it is a subconscious effect learned through social experience, in the ideal world this learning will not happen, and in the transitional world, over time, other experiences will rewire the learning. This is the general idea on which I build the theory of the ideal society. The details of EP adaptations widely accepted by the field, will be presented to strengthen the specifics of the idea. Strengthen it enough that extrapolating to see that the myriad other maybe-adaptations are irrelevant, becomes trivial.

1.4 Behavioral genetics

The science of genetics started with Gregor Mendel and his study on cross-breeding different strains of peas. He correctly identified discrete units of transmission for inherited traits in plants. The branch of genetics which deals with the inherited traits in human behavior, behavioral genetics, started in parallel with the work of Francis Galton. Unfortunately, until a few decades ago, most work, including Galton's, was biased heavily by subjective views, specifically racism. We will look at modern behavioral genetics, as exemplified by the texts *Behavioral Genetics, 2000 ed.* by DeFries, McGuffin, McClearn and Plomin, and *Human Genetics for the Social Sciences* by Gregory Carey. The first is a collection of scholarly articles on the subject, and the second a tutorial-style book. Appendix A on page 349 describes the basics of cells, chromosomes and genes.

1.4.1 Tools

In general, this field assumes all traits are from combining genes and the environment. The environment is thought to consist of the familial and the non familial environment. The definitions of these are not intuitive. The familial environment is all those elements which make relatives similar on a phenotype, that is a behavioral trait. The nonfamilial environment is all those things which make relatives different. A dad treating his children differently would be part of the nonfamilial environment.

The main tools of behavioral genetics are adoption studies, twin studies and pedigree analysis. Adoption studies survey behavior of adopted children and biological children to tease out what genes contribute. Twin studies look for differences between identical and fraternal twins. In some cases, they contrast identical twins separated at birth with those brought up together. Pedigree analysis analyzes the genome in a family line to identify genes associated with an inherited trait.

Twins can be identical or fraternal. Identical twins are monozygotic, born from the same zygote (egg) splitting into two. Fraternal twins are dizygotic, born from two different spermatazoa, sperm cells, fertilizing two different ova, egg cells, producing different embryos. Monozygotes have the exact same genetic sequence. Genetically dizygotes are similar to siblings, who share half the genome (here the word applies to that part different from the baseline human genome) on average. Monozygotic twins can be monochorionic, having shared the outer membrane of the fetal sac in the womb. Or they can be dichorionic. Monochorionic twins can also be monoamniotic, having shared the inner membrane of the fetal sac as well, or they can be diamniotic. Genetics is interested only in the difference between monozygotes and dizygotes. The other divisions come into play when we need to look at the differences in the prenatal environment.

The two main forms of genetic analysis are linkage studies and association studies. Linkage looks for well-known genetic markers in the chromosome. If many people in a pedigree with the same trait share the same linkage marker, that means a gene located close to the marker probably contributes to the trait. Close to means a position close enough that recombination, which effectively splits chromosomes passed to offspring, keeps the marker and the gene together. Distance between gene loci is statistically represented by the recombination fraction, a value between 0 and 0.5. It is actually the probability a two-locus haplotype (gene set) is not transmitted intact. Because the value never exceeds ½, it is not mathematically a probability value. A probability value has to lie between 0, the impossible, and 1, the sure to happen.

Association analysis scans the entire genome of a set of people with a trait, to identify common alleles. It uses complex computer programs from statistics and string searching.

1.4.2 Heritability

Heritability is a quantitative measure capturing the degree to which genes and the environment cause a trait to vary. Mathematically, it is the square of the correlation coefficient between genotypic values and phenotypic values.

Consider as an example, a trait of impulsivity scored on a scale of 0 to 5, timid to bold. Each individual has a specific gene set sequence and a specific trait or phenotypic value. Let us assume there are 3 individuals with genotype sequence AaBBCc, with phenotypic values 1, 3 and 2. The genotypic value for sequence AaBBCc is then 2, the sum of the phenotypic values divided by 3, that is the average.

The genotypic value is the mean of the phenotypic values for all individuals with that sequence. Phenotypic values are numerical scores on a particular trait. The difference between genotypic and phenotypic values for any single person indicates how much he or she deviates from the mean because of genes. The total correlation hence captures how much genes contribute to the trait being away from the mean. Heritability is denoted by h^2. It measures how much genes cause a trait to vary.

1.4.2.1 Misperceptions

Heritability does not measure what percent of behavior is controlled by genes. It measures how much genes influence the trait varying from its average, in a specific population. Variation in behavior is different from the behavior itself. Heritability does not measure how much of a behavior is controlled by genes; it measures how much of the variation in behavior is controlled by genes.

Heritability assumes both genes and the environment contribute linearly to the phenotype. It assumes there is no gene-environment correlation. Identical twin studies rarely venture outside the developed world and the implied cultural similarity in the environments of identical twins raised apart skews the numbers. The family environment depends not just on the family itself; it depends heavily on the values, beliefs and cultural attitudes imbibed from the social milieu. Twins raised apart in different cities in the West are anchored in the same mores and morals, are exposed to similar education systems, read roughly the same books, play the same games, sing the same tunes, and watch the same movies. Their formative influences are the same. The partitioning of science has caused anthropology, the study of culture, and behavioral genetics to be totally separate. As a result, behavioral geneticists, with little understanding of how to account for cross-cultural differences, have ended up largely ignoring how most of the world behaves. Heritability measures, as Matt Ridley points out [REF HERE], [FIX] is a measure of how much genes contribute to trait differences for a population within the homogenous West.

1.5 Neuroscience

I cover the basics of neuroscience, emphasizing how our senses and awareness work, in Appendix A on page 349. To understand the cited papers, basic knowledge of neuroscience is a must. This section explains the common terms used in the science.

The brain is made of cells called neurons, which communicate with one another through chemicals known as neurotransmitters. Neuronal connections from one region of the brain to another are called projections. The regions are divided at a high level into three: the brain stem, where the spinal cord meets the brain, the midbrain and the forebrain. Phylogenetically, evolutionarily, the brain is divided into the cortex and the subcortex, which includes the limbic system. The cortex is the set of conscious sensation, planning, decision-making and higher-order processes. The subcortex mediates subconscious processes. Both cortical and subcortical processes can be genetic or learned or, most likely, a combination of both. The brain is also divided into a left hemisphere and a right hemisphere, connected in the middle by the corpus callosum, and at the bottom by the brainstem.

There are some frequently mentioned subcortical regions. The thalamus relays most sensory input such as sound and vision. The hypothalamus regulates the body clock, and the urges to eat, drink and mate. The hippocampus is considered crucial to indexing long-term memory, while memories themselves are stored all over the cortex. The amygdala controls emotions and conditioning such as fear conditioning to a stimulus. The cerebellum and basal ganglia are involved in motor learning and predicting rewards.

The cortex has a different region for processing each sense. Thus there is a visual cortex, an auditory cortex, a somatosensory cortex (touch and pain) and so on. There are association cortices which process such stimuli further. There is a motor cortex which regulates voluntary movements. The prefrontal cortex is the one region different, larger, in humans.

Details of various structures will be pointed out as and when I cover the wants or behavior they influence.

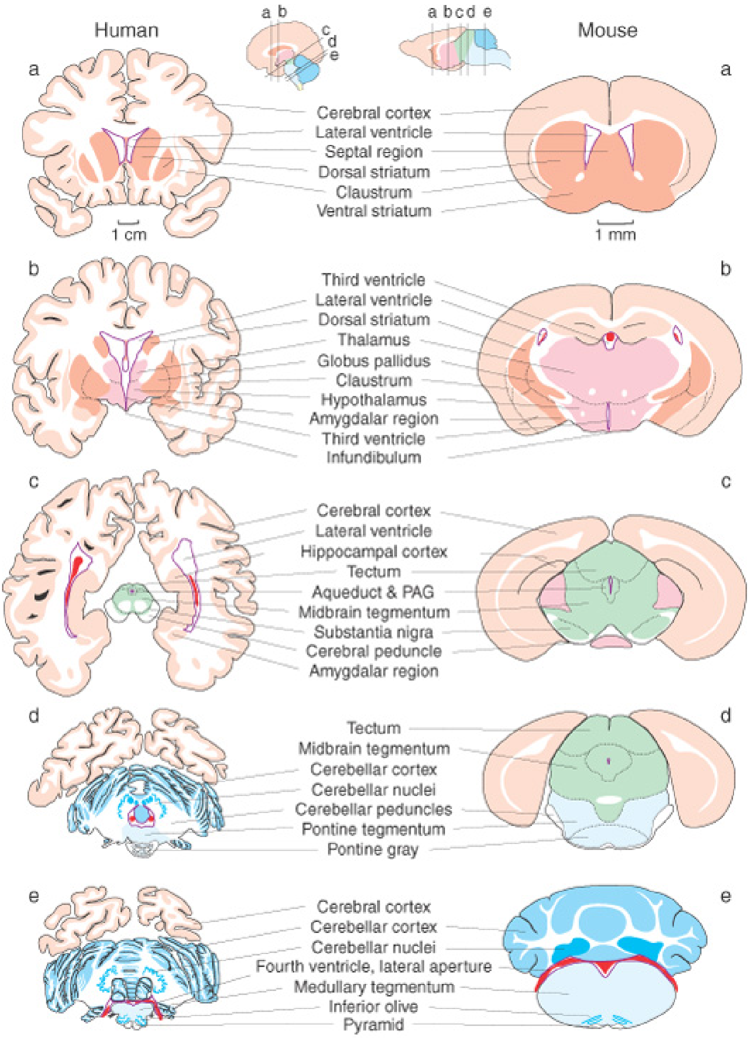


Figure 1.2: Human and mouse brains, rostral to caudal

The brain is three dimensional and pictures showing its parts are two dimensional. To get around the problem, three axes are defined to visualize the system. The first, running from the nose to the back of the skull, is the rostral-caudal axis. Regions nearer to the nose are rostral, and those nearer the back of the skull caudal. Similarly regions to the top are dorsal and to the bottom (nearer to the neck), ventral. The third axis splits the skull left, right. Regions near the midline of this split are medial and those farther to the left or right, lateral. Thus a rostral ventro medial region is one near to the face, near to the neck, positioned in the middle of the left/right split. These terms are not generic to science; other fields use the same words to define a different set of axes.

1.6 Neurochemistry

Neurochemistry deals with hormones. Hormones are proteins generated mostly by glands and often carried in the blood to other parts of the body. Neurohormones are generated in the brain, by neuroendocrine cells, for example in the hypothalamus. Circulating hormones are taken in by parts of a cell (usually neuronal cell) called receptors. Each hormone is associated with a different kind of receptor. There are genes which code for hormones, and there are other genes which code for receptors. Genes do not code directly for hormones. They code for neuropeptides which get converted to hormones via a series of chemical reactions. At each step, often enzymes catalyze or control the reactions, and these enzymes are coded for by other genes.

Neurochemistry deals primarily with what hormones do. There is little in the way of how they do it, for hormones acting on the brain. The results are not well integrated into an overall theory of the brain either. The molecular reactions hormones cause are partly known, but the way from reactions in a cell to actual behavior is ill charted.

I will cover the function of various hormones as and when we encounter them. Only those which regulate specific behavior of interest to us will be looked at. The field is small, since the how of hormones is not our concern.

Table 1.1 Human hormones listed in the references

Short name	Name	Description
ACTH	adrenocorticotrophic hormone	stress
AVP	vasopressin	urination, blood pressure, attachment in male rats
CRH	corticotrophic releasing hormone	stress
CORT	corticosterone	stress
DA	dopamine	reward learning, stress, consciousness
DHT	DihydroTestosterone	a version of TST
E1	estrone	estrogen group, reproduction
E2	estradiol	estrogen group, reproduction
E3	estriol	estrogen group, reproduction
EP	epinephrine	same as adrenalin
F	cortisol	adrenal, stress related
FSH	Follicle-stimulating hormone	egg release
LH	lutenizing hormone	egg release
MT	melatonin	sleep/wake cycle (circadian rhythm)
NE	norepinephrine	stress
OT	oxytocin	muscle contraction, breast feeding, attachment
P or P4	progesterone	reproduction
PRL	prolactin	milk production
TST or T	testosterone	sex drive
5HT	serotonin	mood hormone

Most of these are released from glands or regions in or near the brain (pituitary, pineal, hypothalamus, ventral tegmental area and so on). The sex hormones are divided into two groups—androgens

(TST and DHT) and estrogens (E1, E2, E3). They are released mostly from the testes or ovaries. The stress hormones (EP, CORT) are released from the adrenal gland in the kidney. Steroids, often thought of as hormones, are actually compounds with a specific chemical structure, and include the sex hormones and proteins like cholesterol. Our wants are regulated directly largely by hormones, and the details will be covered in later chapters.

1.7 Summing the evidence

The fields, EP, behavioral genetics and neuroscience are new. Many theories are likely to be overthrown or refined in the future. Most are considered tentative by many outside the field. To see why, let us take one example from each field and sum up the nature of the debate.

1.7.1 Evolutionary psychology

Women generally attend more to self-grooming than men. Is this innate? Let us assume evolutionary psychology says so. But we know mothers teach girl kids to pay more attention to hair and dress. This is learned behavior on a girl's part. The evidence is everywhere. True, says EP. But such teaching is cross cultural. Why do women everywhere teach their girl kids to pay attention to their looks? Why do they tend universally to be so? There must be some innate wiring this teaching accords with. In the ancestral past, competing sexually for fit men meant women presenting themselves more attractively. Those who were, or managed to look, more attractive led better lives, bred more, and passed the genetic tendency on. How to look better is learned and taught, but the need to look better is hardwired. It will be triggered in a setting where women have to work toward getting high-ranking mates. That setting still exists in all our current cultures. This is why the trait has to be thought innate.

This argument hinges on the cross-cultural data. But, respond opponents, everything that is universal across cultures does not follow how we tend to be innately. In many cases, cultures imitate the behavior of the dominant one to catch up to its standard of life. The current spread of the Western way is an example. One hardly needs references to back this point. So traits we see universally today may have arisen because in the historical past, some dominant culture started it, to deal with their local climatic or environmental conditions, and others just picked up many traits of the leading society wholesale. Such cross-cultural pushing of traits is hard to track, but is possible.

At this point, the debate stalemates. More data is unlikely to resolve the thread, since the central issue of whether this trait arose in a dominant culture and was mimicked by the rest, and thus became universal, is difficult to resolve. Historical records are rarely precise enough to answer such questions. An EP scientist would look for supporting evidence from other lines of argument.

Cultural imitation hobbles EP. At present, on many basic issues, the culture followed by most is of the West. In many lands, almost all popular songs hymn the conquering march of Rome. Is imagining romantic chivalry species-typical biologically? It has become difficult to know. Is eating three meals a day from our biology? Is removing facial hair? Or any hair? Cross-cultural studies can easily point that way. Biology says not, since for most of our evolutionary past when our EP traits developed, full hair was the norm.

1.7.2 Behavioral genetics

Consider ADHD (Attention Deficit Hyperactivity Disorder). Pairs of identical twins have it more than pairs of fraternal twins. So genes must cause a part of it, say 30%. The remaining 70% of the disease is from the environment. As we saw, behavioral genetics theory does not say this, but this is commonly how the findings are reported.

Opponents point to the pairs of discordant identical twins, where one gets ADHD and the other does not. By definition, the environment caused the ADHD in this case. So it may be that some ADHDs are genetic, and some environmental? The easiest way to check is to see if children of the discordant twins have the same rates as children of MZ twins in general and children of concordant twins. If the rates match, then the gene contribution to ADHD has stayed the same in both the concordant and discordant pairs. In this case, the gene contribution is not sufficient to cause ADHD. It cannot, by itself, trigger it. The environment plays a part. The disease is characterized by a genetic disposition which the environment fans. We can create environments where the disease will not kick in, for all the cases.

Identical twins share all genes. Hence all differences between them are environmental. But all their similarities are not genetic. They may both like or dislike cats, for example. Identical twins look alike. Cats may respond to them the same way, and this may trigger the same cat preference in them. Humans, especially strangers, also often respond to similar looking people the same way, on a first contact. The first impression bias identical twins create is the same. Some of their similarities may be due to environmental sameness caused by such biases from others. Behavioral geneticists have largely ignored this gene environment correlation in their studies, bumping up the heritability numbers. Modeling such a correlation requires understanding how people react socially to other people's physical genetic qualities (everything from looks to the way one laughs). This is complex.

On the specific example of ADHD, psychiatrists are on slippery ground. We are not evolutionarily made to sit in a place and listen to a lecture for hours on end, day after day. Our environments, as per EP, do not match our adaptations, and ADHD, at least the attention deficit part, is to be expected.

1.7.3 Neuroscience

Neuroscience has no integrated theory of the brain. Or even an integrated theory of how any brain region works. A single neuron, unlike a single transistor of a computer, is not a device with just 2 or 3 states. It packs many proteins, and other molecules, and its state depends on a huge number of molecules. It can hence exist in many states. The molecular workings of a neuron are not fully understood. At every level, neuroscience is incomplete. Analogies with animal brains are the second source of problems. All areas of the human brain have equivalent regions in the chimpanzee brain. This leads to the question of how the analogous areas have been mapped, since humans are so different from chimps. There is also the question of how much hardwiring of the adult brain represent genetic coding, and how much learning influence. All humans share a similar upbringing when it comes to language (all of us are exposed to it from childhood), general interaction with other humans, and rearing by parents, with some common moral rules limiting stealing, being violent and wantonly destroying. Brain regions identified by scans in adults may result from genes or learning. In some cases, such as the WFA (Word Fusiform Area) which preferentially understands letters of the alphabet, evolutionary psychology indicates the region is from learning. Writing developed recently, and genes could not have changed fast enough to develop a specialized area in just a few thousand years. The alternative, that the WFA represents an innate tendency which those who invented writing took advantage of, seems unlikely because studies have shown illiterates do not have a WFA. However there are some open questions since enough studies have not been done. There is also the problem that EP often relies on neuroscience; neuroscience relying on EP to show a point can lead to circular proofs.

1.7.4 Putting it together

So, to prove a point, one has to to accumulate evidence from the three fields separately. Established textbooks and handbook compilations from authors in leading institutions are reliable sources, with surveys, summaries and meta-studies of the field a second. Isolated papers will be mentioned only in passing. Points which are neutral might be mentioned where they contribute to understanding the salient parts.

We will now turn back to the present. Our needs and wants as we now know them. How we came to be is the background for the biology we have, to generate and satisfy wants.

I will present evidence from various branches of science and social studies, to address each separate want and trait. Some branches are not suited to analyzing certain wants or traits, either because they are out of scope or because the results are too raw to be used. Now that the tools used to analyze have become familiar, let us turn to the controversial want, sex. A want that interests the playboy and the puritan.

Table 1.2 Branches of science used

	EP	Neuroscience	Behavioral genetics	Anatomy	Historical records	Animal studies: Apes	Animal studies: Primates	Animal studies: rodentia	Animal studies: mammals
Food & Drinks	x	x	-	x	-	x	-	-	-
Sex	x	x	-	x	x	x	x	x	x
Sleep	-	x	-	x	-	x	-	-	-
Rest	-	x	-	x	-	-	-	-	-
Excretion	-	x	-	x	-	x	-	-	-
Avoiding pain	-	x	-	x	-	-	-	-	-
Behavior: aggression	x	x	x	-	x	x	-	-	-
Behavior: competition	x	x	x	-	x	x	-	-	-

Table 1.2 Branches of science used(*continued*)

	EP	Neuroscience	Behavioral genetics	Anatomy	Historical records	Animal studies: Apes	Animal studies: Primates	Animal studies: rodentia	Animal studies: mammals
Behavior: jealousy	x	x	x	-	x	-	-	-	-
Behavior: violent mental disorders	x	x	x	-	-	-	-	-	-
Behavior: love and attachments	x	x	x	-	x	x	x	x	-
Behavior: group formation	x	x	-	-	x	x	x	x	-

2 The story of sex in time and space

Philosophies have been built on humans behaving naturally. These have postulated that nature's way is best; something we should stick to. Most popular science books on evolution contain numerous examples from the plant and animal kingdoms. These examples support their particular points, whether it be to prove how grand selection's design is, how blind nature could be, why only genes matter, and why genes are not the only things which matter.

The animal kingdom is vast and varied in behavior. There are thousands of species of just rodents, tens of thousands of fish, and hundreds of thousands of insects. There are more than a million species of animals. Each has arisen selected for a specific environment and evolutionary history. Examples from there cannot be used to prove any point, as counterexamples can be found for any theory. Selected examples, which ignore the species which do not fit the theory, are hard to falsify without knowing the many species in minute detail. Theories built on such examples, and extrapolated to humans, can be used to object to an ideal world. To address this, let us look at behavior related to sex and mating in the major orders of life, with specific examples for some common theories. We can also see how closely related humans are to the various orders, in anatomy and the environment they habit, to see how credible extrapolating would be.[13]

2.1 The major orders of life

The first main division of life is between the cells with no nucleus, the prokaryotes, mostly bacteria, and everything else, eukaryotes. Fungi, including amobea, are a class their own. The rest are divided broadly into plants and animals. Animals are divided into vertebrates and invertebrates, those with and without a spine. The invertebrates consist mostly of the insects, but also include molluscs, and crustaceans like crabs and corals. Vertebrates are divided into five major groups: fish, amphibians, reptiles, birds and mammals. Mammals consist of groups lagomorpha (subgroups rodents and glires, that is rabbits and hares), primates (monkeys), carnivora (the canids such as dogs and foxes; the feloidea which contains cats, hyenas and mongooses; and the pinnipedia of seals and walruses), the ungulates (hoofed animals such as the common herbivores from cow to elephant, but also the cetaceans, that is the whales and porpoises), and so forth. Figure 2.1 on the facing page captures the evolutionary tree of the major mammal groups. The division is not exhaustive nor the uniquely accepted one; it is just the convenient one, and close enough to the strict biological hierarchy of domain/kingdom/phylum/class/order/ . . . division, with its many subdivisions and variations.

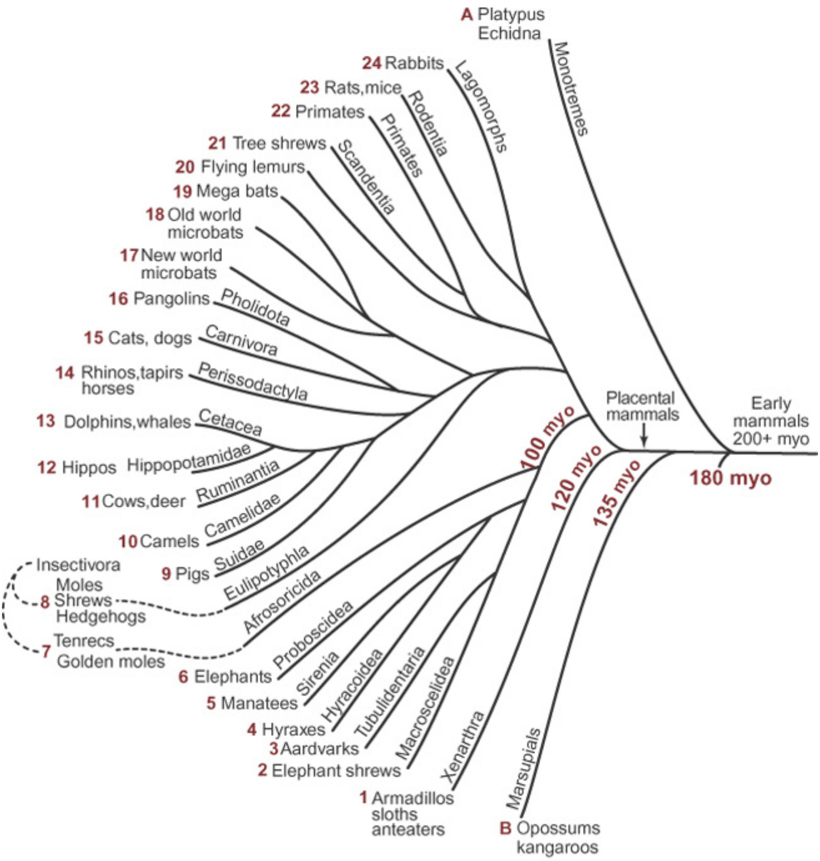


Figure 2.1: Evolution tree of mammals

2.2 Origin of mating

Life is defined by molecules replicating indefinitely. While individuals die, the information from the first live molecules continues on, modified periodically by mutation. The first molecules to come together in the long story of life were probably the amino acids. These would later join up to form RNA, able to replicate. Eventually, RNA would convert to the DNA form for the storage phase, with RNA being the operational code.

How replication started is largely unknown. Even the above sequence is mostly guesswork from biologists. At any rate, eventually, DNA acquired an envelope, the cell membrane, and cells began replicating. The first unicellular organisms, the bacteria, are prokaryotes, with no nucleus. Mating seemingly started at this early state. More properly, merging of multiple unicellular bacteria, exchanging genetic material and creating two new bacteria, came about. Since the two would be identical except for genetic material, no sexes existed. Such bacteria are still around.

2.3 Origin of two sexes

Eventually, prokaryotes sheathed their DNA inside a nucleus and became eukaryotes, such as amoebae. The first eukaryotes were single-celled, but eventually multi-celled organisms came to be. Some of the simplest such are the fungi, which straddle the plant and animal boundary. Probably the earliest plants are the algae.

Some algae have a + form and a - form which mate just like the primitive bacteria merge. However the + form mates only with the -, and not with the +. Both the + and - have equal amounts of DNA and other material, and hence cannot be considered either female or male. They are considered isogamous (iso: equal, gamete: seed). Two sexes exist, but they are symmetric.

Why not continue splitting or merging the old way? The main theory is that the sexes arose to prevent self-fertilization when merging. But the theory has issues explaining why only two. If more than two sexes existed initially, genetic drift would have winnowed it to two, over a long enough period. Also, the minimum check required to ensure no self-fertilization would be that of a single nucleotide at some specific location. This would have led to a four-way split, of A, T, G and C groups, all able to mate with the other three. But nucleotides can also be grouped into two, as the purines (A and G) and the pyrimidines (T and C). Molecules of the first group are larger-sized than those of the second. Disallowing mating between matched purine-purine and pyrimidine-pyrimidine pairs at a single nucleotide would be an easy, optimally shortest, check. The two strands of a single chromosome pair this way. If such a mechanism were to be assumed, we would end with exactly two groups to begin with. The two sexes.

2.4 Origin of male and female

Biologists define a male as the individual with the smaller gamete (sperm) and the female as the one with the larger (egg or ovum). Why the sexes became differentiated this way is also speculative. One theory is that this was due to disruptive selection. In an isogamous species, there would be selection pressure for the gamete to get smaller. However, as the gamete gets smaller, it is less likely the offspring would survive. One equilibrium situation is where the gamete of the + group gets bigger and of the - group gets smaller, but more in number. The + group then becomes the female and the - group the male.

Eventually, males and females diverged more for reasons we saw earlier—the difference in parental investment. As life grew anatomically more complex and mobile, organisms developed reproductive organs, differentiated between males and females.

2.5 Asexual reproduction

There are species which reproduce by cloning, with no sex. The desert-grassland whiptail, *Cnemidophorus uniparens*, is one such. Eggs develop into offspring identical to the parent. By convention, these are considered to be females. The genus itself has some species parthenogenic (birthing or ‘genesis’ from a virgin or ‘parthen’ ovum) and others not. The uniparens parthenogen is triploid and seemingly a hybrid of two other species of the genus. At least 27 species of this genus reproduce asexually.

Pseudocopulation is where a female behaves like a male mating with another female, mounting her and rubbing or thrusting. C. uniparens females exhibit pseudocopulatory behavior similar to their ancestral species C. inornatus, which reproduces sexually.[14] But in C. inornatus the hormone triggering male copulatory behavior is testicular testosterone, while in uniparens it is progesterone. The neural basis of the behavior is expected to be the same.[15]

Many parasitic species reproduce asexually while within the host, and then reproduce sexually just before leaving and dispersing. The idea behind merging or mating seems to be to produce genetic variety to handle diverse conditions likely to be encountered after dispersal. Also, recombination diversifies genes helping species fight pathogens such as bacteria and viruses better. Supporting this, there are ticks, lice, bugs, flies, moths and the like where males disappear as one moves from the tropic to the poles, where there are fewer pathogens. As we saw before, this is the Red Queen theory of the origin of sexual reproduction to counter infectious microorganisms.

Parthenogenesis occurs in organisms as big as female sharks, specifically in a hammerhead and possibly a bamboo shark, as well as in some birds, reptiles, amphibians and bony fishes. The species seemingly reproduce asexually when no mate is available for an extended period. Only females are known to be parthenogenic. Mammals never are, except in the lab, by cloning. Cloning is one possibility for parthenogenesis. In diploid parthenogens with chromosome pairs, the resultant embyro might have undergone chromosomal crossover, in which case the genome would be slightly different from the mother. The case of effective genetic cloning in plants is called by botanists, believe it or not, apomictic thelytoky.

2.6 Sex determination

All sexually reproducing species have sexes, and mechanisms to differentiate sexes. Some species have both sexe in the same organism. Sex, is stable, but there are the exceptions.

2.6.1 Chromosomal differentiation

The sexes are differentiated by chromosomes in mammals and birds. In most mammals, males carry one copy of the X and one copy of the Y. Females carry two copies of the Y. So males are the heterogametic sex, and females the homogametic one. In birds the situation is opposite. The females are heterogametic (Z and W paired chromosomes) and males homogametic (Z and Z).

The insect order containing ants, wasps and bees is the Hymenoptera, with membrane-like wings (hymen is Greek for membrane and pteron for wing). Ants have wings? The drone males which mate, and the queen female, do. In these the females are diploid, with chromosome pairs. The males are haploid, with only one set of each chromosome. This haplodiploidy is maintained by females developing from fertilized eggs and males from unfertilized ones. The egg itself is haploid. This also means females can decide whether their offspring should be male or female by choosing to fertilize the egg.

2.6.2 Environmental differentiation

Some reptiles, including snakes, have sex chromosomes providing GSD (Genotypic Sex Determination) while others, such as some species of lizards, turtles and alligators, have TSD (Temperature-dependent Sex Determination). In TSD, the temperature at which the egg is incubated decides the sex. In at least one species of reptile, an Australian skink lizard, both GSD and TSD operate, with a low temperature forcing an XX to develop as a male.

A burrow-dwelling marine worm, the green spoonworm *bonellia viridis* is truly special. The female, about 8 cm long, has an enormous proboscis about 80 cm long, which it uses to feed. It remains mostly settled in its burrow. The tiny male is even more sedentary, living as a parasite inside the female's uterus. The larvae have no sex. If one contacts a female's proboscis, it settles, enters her, and develops into a male in about three weeks. If no female is encountered, the larva will develop into a female in about two years.

In several parasites, whether a larva matures into a male or a female depends on the crowding encountered. If many other larvae are around, the larva matures into whichever sex matures faster for the specific species. Orchids develop as females in bright sunlight and as males in shade. The females are bigger. In these cases, it is adaptive for the species to mature into the sex optimally suited to the environment.

2.6.3 Hermaphrodites

Still other species either end up with both male and female gametes, or change from one to another in their lifetime. This is hermaphroditism. From Hermaphrodite, the son of Hermes and Aphrodite, who merged with a nymph to end up half male and half female. As opposed to gonochorism, separate males and females. Somewhere in between is the nematode, which as we will see later has both males and hermaphrodites but no females.

Hermaphroditism can be sequential or simultaneous. In the first, the organism changes its sex midway, while in the second, the organism is truly bsexedr from the beginning. Among land vertebrates, no hermaphrodites are known, and no sex reversal has been induced in the lab. Among vertebrates in general, some fish go from being a female to a male, protogyny. Coral reef fish such as *labroides dimidiate* change from female to male when the sole male in a group dies or disappears. The largest and most dominant female switches. In the bluehead wrasse *Thalassoma bifasciatum*, some individuals reproduce first as female, and later, at larger size, mate as males. The reverse, male to female change or protandry, is rare in fish, but does happen for the little coral fish, *Amphiprion*, when the female in a monogamous pair is removed. The largest juvenile then becomes the new female. Such changes are a one-way street for all vertebrates which exhibit it, and typically take a month.

Among invertebrate sequential hermaphrodites, protandry is more common. The shrimp, *Pandalus jordani*, is one such. Females produce more eggs the older or bigger they are. The same shrimp reproduces as a male when large females are plentiful around it during the fall breeding season, and otherwise as a female. Some invertebrates and plants can change sex in both directions in the same lifetime.

Earthworms, many snails, and many/most plants (producing both pollen and egg) are true simultaneous hermaphrodites. They have elaborate mechanisms to prevent self-breeding. This is common in many sessile (immobile) plants and animals. There are simultaneously hermaphroditic fish, alone among the vertebrates.

2.7 The sex ratio

The sex ratio is the ratio of males to females in a population of a species. Why is this important?

Consider starting a new colony on Andromeda. Carrying more people is expensive in that the size of the space module has to be larger and propulsion systems more powerful. So say we can send only a seed population of a hundred, not to be added to in the near future. Assuming mating will be random, should we send fifty males or ten males?

Ten males, or fewer, is more sensible, since the number of offspring is controlled by the number of women in the group. Adding more males would not increase the potential for offspring, with mating random. Why did not selection use the same principle when colonizing Earth? Why do we see sexes about equal in many animals?

Let us look at a population of fifty men and hundred women. If we assume each woman has four children, it follows that each man has an average of eight. An average man has more children than an average woman. It makes more sense to have boy babies than girl babies, since the chances of gettings one's genes to grandkids increases with boy babies. So, whenever a sex disparity arises, natural selection will correct for it automatically. Babies of the rarer sex will be preferred since they will have more kids, on average, down the road. This is not an explicit preference by the parents. A mutation that increases baby boys will be preferred by the sieve of selection. So the sex ratio should stay in equilibrium at one. This is a special case of frequency-dependent selection where different alleles stay in equilibrium, because the rarer one automatically provides a selective advantage because it is rare.

This analysis, originally from Fisher, assumes many things. Picking apart those assumptions leads to entire books on this single subject. For example, we assumed genes are passed down the same way to males and females. This would not hold for the haplodiploid system mentioned earlier. Genes passed down to a male offspring are guaranteed to wind up in all grandkids, while those passed down to female offspring have only a 50% chance of going further down. In theory, this should skew the ratio toward males. In the hymenoptera other factors come into play negating the analysis. Another confounding issue is that males could be more prone to die before sexual maturity. This could lead to more boys being born than the girls, though the adult ratio stays at one. The natural sex ratio of TSD organisms is a problem since there is no proximate way to control it. For one species of Alligators, the sex ratio at hatching, the secondary sex ratio, is five females to one male. They have no primary sex ratio, the ratio after conception.

For the haplodiploid insects, under certain cases the sex ratio is at 3:1 biased in favor of females. The haplodiploid case illustrates the complexity involved in calculating the ratio in theory. For these insects, males have only one part of paired chromosomes, while females have both. Eggs and sperm, as usual, have only one part of a pair. Males arise directly from unfertilized eggs, and females from egg and sperm fused. As a result, a mother is related 50% to both sons and daughters, but a son is related 100% to the mother and 0% to the father (no father at all). Sisters are related 75%, brothers 50%, and sisters 25% to brothers. A daughter is related 50% to both parents. Males can produce only daughters. So a father is related 100% to his daughters.[16]

What sex ratio works from a queen's point of view? Since a queen is related 50% to both sons and daughters, it looks like genetic traits are passed on with equal chance, and so the 1:1 ratio is to be expected just as in standard diploid organisms. However, grandchildren are trickier. Any gene passed through the son will end up in any granddaughters, guaranteed. Genes passed on through daughters are further attenuated 50% by the time we get to their grandkids. So preferring sons might seem the right option. But since males can produce only daughters, preferring sons is counterbalanced by more granddaughters automatically produced. The net effect is the sex ratio is pulled back toward 1:1, though this may not be intuitively obvious.

Let us look at the math. The equilibrium is when the chances of a gene being passed on through a daughter and a son are equal. So if the sex ratio is $x:1$ in the female's favor, then the queen would have x daughters to each son. Both sons and daughters carry half of her genes. So how well a son manages to pass the gene further on should equal x times how well a daughter manages to pass the gene on, in equilibrium. A son has only daughters, and because of the sex ratio, will mate with exactly x females producing x daughters, all carrying all his genes. So the son manages to pass on x copies. A daughter can have sons and daughters, equally related at 50% or 0.5, in the ratio $1{:}x$. This means her chance of pushing the gene on is $0.5 + 0.5 \times x$. This should equal x, the son's potential. A value of 1 for x satisfies this equilibrium. Plotting the values on a graph can show no other real-world value for x does.

So where does the 3:1 ratio come from? In these insects, a queen's daughters are workers, mostly sterile who take care of the brood. These females are 75% related to sisters and 25% to brothers. Hence they would care more for sisters in a 3:1 ratio. Once again, the math looks deceptively simple but is not. In the real world, the sex ratio in hymenoptera vary because some workers are fertile and others not, and the ratio of sons produced by the queen as opposed to workers varies.

2.8 Development and sex differentiation

The development of reproductive organs, different between the sexes, is initially controlled by the sex determiner, genes or the environment. The process of general development from the first fusion, ontogeny, is important because evolution in the higher life-forms works by modifying the later stages of development. Modifications to the earlier stages are riskier and would likely lead to unviable foetuses. Evolutionary changes have to be largely a sequence of modifications or additions at the tail end of ontogeny. The evolutionary history, phylogeny, of a species, is hence mirrored to some extent in its ontogeny.

2.9 Nature of ovulation

Mammals have fertile cycles. In many there is a period of estrus when the female is sexually receptive. In rats, this is about one half of one day out of a four or five day cycle. A cow is in heat for about half a day out of every three weeks. When not in estrus, females are typically unattractive to males. Estrus generally corresponds closely to the fertile period. Many mammals advertise estrus through swellings near the genitalia. Humans have no estrus and no advertising of the fertile period.

In each cycle, in the ovaries, one or more follicles grow from a small group of inert cells into a large mass secreting estrogen. The follicles are attached to the ovum, preproduced at birth. Shortly before the ovum is released, its meiosis resumes. A surge of the pituitary hormone LH triggers ovulation. After ovulation, the follicle may be converted into the corpus luteum, secreting progesterone, important for implanting the conceptus (the earliest foetus) in the uterus.

Mammals have three basic types of cycles:

1. Ovulation and corpus luteum formed spontaneously. These happen every cycle. Copulation is not required for either. If no fertilization happens, then the corpus luteum vanishes. The uterus also signals the ovary to start producing another egg for the next cycle. This cycle is seen in dogs, cows, guinea pigs, goats and the primates including us. The cycles are typically long, of the order of weeks.
2. Ovulation is spontaneous but the corpus luteum will form

only if the female mates. This is seen largely in the rodentia: rats and mice. The cycles are short, of the order of days. Stimulating the vagina releases a hormone, prolactin, which triggers the luteum to form.

3. The female ovulates and forms the corpus luteum only on mating. The induced ovulators include the glires (rabbits and hares), ferrets, cats, lions, lemmings, voles and camels. If the female does not get to mate, she may stay in estrous for days or weeks. The mating act needed to trigger ovulation is the inserting of the penis, which the vagina senses as touch.

2.10 Mating strategies

Males compete for females across the animal kingdom, except in the one living species closest to us. Fruitflies, drosophilia, do, since all of a female's eggs can be fertilized by sperm from the first mate. Elephant seals are among the most aggressive in competing for females, with some even dying either while fighting others or after mating. The Hamadryas baboon, *Papio hamadryas*, has a male dominance hierarchy which decides who gets to mate more. It is matings during the swelling period of the estrus cycle which are most valuable. Many primates have similar systems, but the link between rank and mating success in primates is probably weaker than in other mammals. It is weakest of all in the bonobo, *Pan paniscus*, where males mate free within their troops and even across. At the opposite end, male rhesus monkeys fight heavily during the breeding season, being seasonal breeders. Some are wounded and may even die.

Females look for cues to health in a male's mating effort. An estrous female rat prefers an intact male to a castrated one, based on odor cues.

In many species of fish, with external fertilization where sperm and egg are both released into the water where they may fuse, exclusive male care of the egg is common. Sometimes then a third fish, a sneak male acting like a female, joins the spawning pair. Small, young males employ the sneaking strategy to avoid attack by the larger males and manage to fertilize eggs at the same time. Bluegill sunfish are an example. Such sneaky routes are seen in red deer, with hummels who never grow antlers and avoid fights, and stag beetles, with horned males and hornless male sneakers.

In some species males use alternate tactics depending on the surroundings. Dung fly males, *Scatophaga* or dung eaters, either guard their territories in the cowpat or lurk in the grass nearby. Crickets are similar, with some males singing and others not. The singers are more often parasitized by warble flies which lay their eggs inside the cricket. When there are more warble flies, there are fewer singers, and more silent satellite males. The males change their strategy to match the environment. It is believed the two strategies are both driven by genes in equilibrium in the population.

Brazilian fig wasps lay eggs inside fig fruits, where the wasps develop. The wingless males mate with the females inside the fruit and die, never seeing the outside world. The males engage in ruthless combat for the females with other males of the same species, but not other species. That is the story for the genus *Idarnes*. In the genus *Blastophaga*, however the males scramble for females rather than fight. The difference is because in this genus, the females struggle into the fig, losing their wings, lay a large brood of eggs, and die. Rival males are likely brothers with half of the genome similar. This nepotistic restraint is kinship selection and inclusive fitness in action.

In species where the female mates just once, as in solitary bees, males go to the extreme of digging young virgin females out of their underground abodes even before they can emerge, which they would eventually have done unaided. In species where females mate repeatedly, being the last to mate is probably better. Since this is difficult to ensure males have a variety of tactics to push their genes through:

1. Displacing existing sperm. Various insects have genitalia designed to penetrate the female's sperm-storage organ and flush old sperm.
2. Inducing a pregnant female to abort and be reinseminated by the second male. Among many rodents including rats, the smell of a novel male causes abortion in a pregnant female, at the early stages of pregnancy. This is the Bruce effect. This has been seen in the lab, and it is unclear whether it happens in nature.
3. Killing the old offspring to get the female to breed again. Male lions in a group, a pride, often band together and raid

another pride displacing its males. They then kill the cubs. Solitary male langurs sometimes do the same. The females are not strong enough to stop this. Which is a proximate explanation, not an ultimate one, but that is the best we have. Among lions, lionesses hunt but the males eat first.

4. Mating plugs and repellants. These seal a female's reproductive tract. One species of worm goes one step further and uses his cement glands to shut down rival males. In the fly *Johannseniella nitida*, the male leaves his genitalia as a plug to ensure he gets to father children. The rest of his body is eaten by the female, giving the offspring an auspicious start with a protein-rich snack.
5. Copulating for a long period.
6. The male sticking to the female after copulation.
7. Guarding of the female. Many primates do this, by guarding females during the fertile period of the estrus.

Many males bribe females with gifts, typically of food. In the black-tipped hangingfly, the male passes the female a prey item, and mates while she feeds. If the prey is not good enough, the female breaks off and leaves. It it is juicy enough, she allows the twenty minutes of copulation needed to transfer sperm. But once that is done, the male might snatch back the food and use it to mate with another female. In some other flies, grasshoppers, and other insects, females feed on glandular secretions from the male while mating; if he stops secreting she breaks off. In some cases, the female eats the male after mating. Nuptial feeding is common in birds as well. Among scorpionflies, males offer a dead prey, or a salivary mass they secrete, or if both fail they try to knock a female out of the air, hold her with specialized claspers and clamps, and forcibly mate.

Among birds which are regularly polygynous, that is where males have more than one mate, is the red-winged blackbird of North America. A male establishes a territory and waits for females to visit him. The first female goes for the one with the best territory. The second female has to decide which is better—being the first mate on second-best territory or the second-mate on the first-best territory. Each succeeding bird has to make similar choices. They would choose the optimal one. This is also seen in migratory songbirds. The net result is if the territories are almost equal, then an almost monogamous system results, since every arriving female will look to be the first mate. If not, there will be a degree of polygyny based on the differential in territory quality. This is the polygyny threshold. The black-and-white lark buntings also choose this way, with shade from sunlight making territories better quality.

This polygyny threshold does not work for mammals, because they cannot move around as well as birds. It is difficult for a female mammal to visit many territories to choose. An alternate mechanism seen among them, as well as in birds, fish and insects is the lek, where males gather at a fixed site to display their prowess while defending a small territory from others. In lek-breeding grouse, the females select the oldest male. Probably because living longer means having won more battles and survived them, implying a fitter specimen.

Males try to advertise their fitness to females. However, selection will favor cheating where some males will develop fake traits. Unfakable displays have to be ones which carry a real cost. The big antlers of deer are an example. They cost the deer food to maintain, and hinder it in other ways. The male deer with large antlers should be fit other ways to be able to maintain them. This is a display that cannot be faked.

2.11 Mating systems

The standard mating systems are one-one pairing, monogamy; one male to many females pairing, polygyny; and many males to one female pairing, polyandry.

2.11.1 Monogamy

Monogamy is common in birds, and rare among the mammals. Mostly it is related to bringing up the young. Monogamous species tend to be less sexually dimorphic, since monogamous males have to compete less for females. The reverse is not necessarily true. Less sexual dimorphism implies reduced male-male competition but this, in turn, does not imply monogamy. The bonobos have about equal-sized males and females because they reduce male competition a different way. Monogamy also indicates about the same age for maturing in males and females. It also comes with issues about who the father is, how to sneak in and mate with a female in another relationship, how to protect against such cuckoldry, how to go looking for other mates to sire more children even when in a monogamous bond, how to protect against such philandery, and so on.

Among birds, as per an old estimate by David Lack, about 92% of the 8600-odd species are primarily monogamous. Monogamous species occasionally go for polygyny. Some ungulates (even-toed grazing herbivores) are monogamous as are some primates like the gibbon, one of the lesser apes. So is a rodent, the prairie vole we will look at in a later chapter.

2.11.2 Polygyny

Polygamy, a harem, is seen in the gorilla. Lions also have prides where a male mates and stays with more than one female. Polygyny where a male mates with more than one female but does not necessarily stay is common in mammals. The difference between the above two systems is mainly in the parenting part.

Polygyny causes males to compete. If access to females is settled by fighting, larger male size will be selected for. Elephant seals are a good example. On the other hand, Weddel's seals, which are also polygynous, have smaller males than females. This is because they mate in water, where competitive skills depend more on being agile than on being big. This is seen vividly in turtles. In land-based ones, males fight over females and are larger than them. In swimmers, the males are smaller. Among snakes, females are larger than males, since males do not fight, they slither and scramble to mate. Terrestrial monkeys are more sexually dimorphic than arboreal, tree-dwelling, ones, since other selection pressures would stop an increase in male size in tree-dwelling species. Some other sexual dimorphism is due to the sexes adapting to different roles, say hunting versus incubating.

2.11.3 Polyandry

Standalone polyandry, where multiple males share a female, is rare. Successive polyandry, where many males sequentially mate with the same female, occurs in shorebirds, gulls and the spotted sandpiper. True simultaneous polyandry is seen in the American jacana, *Jacana spinosa*. In the last two species, the females are bigger than the males, and the male tends the eggs.

2.11.4 Sex reversed species

Biologists define a female as the individual with the larger gamete. This mostly accords with what is popularly seen as male behavior, but not always. Such sex-role reversals happen in insects, reptiles, amphibians, fish and birds, but not in any mammals. The giant water bug, *Abedus herberti*, residing in the creeks of Arizona, has the female laying its eggs upon the male's back. The male incubates the eggs. The female bug courts, though the male initiates copulation. The female does not aid in brooding duties.

Sea horses and pipefishes, from the family Syngnathidae, have males with brooding pouches. This is a slit down the belly where the female lays her egg. Males then gestate the young fry, and when that is done, they are expelled in clouds from the belly. The female initiates courtship. Copulation is also reversed, with the female inserting her genital papilla into the male's pouch, transferring the eggs. Insertive behavior in mating and smaller gamete size do not always match.

The phalaropes, little shorebirds, have bigger and more aggressive females and bolder, brighter plumage during spring. A female picks a male and jealously accompanies him, threatening away other females as the couple swims together. Males are not so aggressive. Once eggs are laid the male takes care of them and the later chicks.

In substrate-spawning fish such as sunfish or sticklebacks, males care for the eggs and tend the fry, but there is no other sex-role reversal. Males still court, are colored brighter, vie with one another and stimulate females to spawn.

2.12 Reproduction

Mating is the first part of the story. Reproduction is the second, and more important, part from selection's point of view. Matings which do not lead to pregnancy are invisible to selection. The reproductive strategies are as varied as mating ones.

First is the question of why organisms do not reproduce the maximum number, since selection favors gene multiplication. It is not enough to reproduce, the young also need to survive at least long enough to reproduce themselves. For this, a large brood may not be optimal. Having fewer siblings may help the children fare better. Clutch size in birds, that is the number of eggs laid at one go, is explained with this model.

The story of the salmon is an extreme. Reproduction is suicidal in the species. The Pacific salmon lives, well, in the Pacific. They spawn, however, in freshwater streams. Once spawned they swim downstream to the ocean. There they grow and fatten up for the return journey, upstream the river. Once back at the breeding creek, they mate and the female spawns thousands of eggs. The adults then die, since they cannot continue. Such a life history of single breeding is called a semelparous history. Iteroparity is where species breed multiple times. Semelparity is common among plants. The bamboo grows for about a hundred years, then flowers spectacularly, and dies. Inverterbrates are also commonly semelparous. Verterbrates rarely so. Among mammals, females are always iteroparous. The male marsupials of the genus Antechinus die before the females birth the young in the breeding season in a population. They all die while the females are pregnant, within three weeks of the onset of mating. Elevated adrenal corticosteroid hormones is one reason, since it helps with mating competition but suppresses the immune system.

Organisms need mechanisms to make sure they mate only with conspecifics, members of the same species. Such mechanisms are needed only to differentiate between other look-alike species which occupy the same geographic region. Fireflies of the genus *Photinus* recognize one another by the sequence in which they flash. Specifically, mating males and females recognize one another via the flashes. The various species have different sequences. In cases where the species did not share the same range in nature, but were artificially brought together, they sometimes did copulate.

2.12.1 Kin selection

We have already seen the kin selection and inclusive fitness theory from Hamilton, and its application in calculating sex ratios in the Hymenoptera. We will look at one specific aspect, recognizing kin.

A mother goat rejects all alien kids, if she is exposed briefly to her newborn. But if an alien kid is substituted at birth, she accepts it. She will later reject her genetic offspring. So in this case recognition happens in a critical period immediately after birth.

Animals rely upon the circumstances of their exposure to others to recognize kin. A pup from one's womb is one's own. The egg in one's nest is likewise one's own. In some cases, the mottling of the eggs is used to identify one's own eggs when mixed with others. Nestmates are assumed to be siblings. A mature female squirrel seemingly behaves preferentially toward her younger sisters only if they were first seen in company with the mother.

In addition, some animals use phenotypic resemblance to gauge kin relationships. Squirrels use odors to check if others are similar to themselves. A bee compares another bee's smell to that of its parents, genetic or foster ones, to decide if the stranger is a relative. At least the small, dark, North American bee, *Lasioglossum zephyrum* does.

2.12.2 Seasonality

Many species prefer to breed seasonally, birthing in the season when resources are more available. Quite a few mammals come into estrus only a few times a year, sometimes seasonally. Land animals rely on light, reflecting day length, to decide the seasons. Water temperature, unlike land temperature, is a good indicator of the season. Hence aquatic animals rely upon temperature as a cue influencing reproductive physiology. In other cases, non-seasonal cues also influence pregnancy. In deserts, rainfall brings about breeding. Australian desert birds start courtship minutes after the first rain ending a long drought. Frogs begin to sing in semiarid central California from the outset of a shower. In rapid-breeding desert animals like the kangaroo rat and other rodents, green vegetation after the rains stimulates ovary activity. In the lizard Brown Anole *Anolis sagrei* increase in humidity stimulates ovarian development. In the vole, *Microtus montanus*, fresh green sprouts eaten chemically trigger reproductive development, allowing the animal to breed when plenty of food is available.

2.12.3 Delayed implantation

Some species control birthing not by changing the mating period, but by changing how long it takes the conceptus to grow. Implantation of the foetus in the uterine wall may not lead to immediate pregnancy. Kangaroos delay gestation by freezing the implanted conceptus at an early gestation stage, at around 70 to 100 blastocyst cells. This arrested pregnancy happens if the young, the joey, are still suckling. A neuroendocrine reflex, from the teat to pituitary to ovary, achieves this. Seals delay implantation for six to eight months, to fit a seasonal schedule of mating and birthing. Humans do not delay pregnancy this way.

2.12.4 Parenting problems

In species where fathers take care of the young, they need to be sure the children are theirs. This is the the anti-cuckoldry defense. The mother needs to be sure the father stays to care for the young, and does not wander off to the next pretty thing across the tree. This is the anti-philandery defense. A bank swallow guards his mate for about a week during her fertile period. Forced mating by intruders happens in this species. It is a chronic social problem in monogamous, colonially nesting birds. Even with all this, turns out a large part of the children in a nest are not the father's. This was demonstrated by vasectomizing the males, and seeing the females still breed and the pair raise the young.

On the antiphilandery side, female birds try to spend time with the males before mating to ensure the male sticks around. In the ring dove, an African pigeon, both birds have to exposed about fourteen hours to each other before they mate. It is the sight and sound of the male that stimulates the female's reproductive system. The eggs hatch after fourteen days. In both pigeons and doves, both parents secrete crop milk, regurgitated from the side wall of the food intake tube. The wall thickens when the parents are incubating the eggs, and the crop milk is specialized baby food.

Philandery is also real among birds. Pied flycatcher males sometimes maintain two territories with a separate mate in each one. The second one is often abandoned after breeding. Cheating the female is hardwired here. In mammals, however, the story is different. Most are polygynous. The ones which are monogamous are largely so only for bringing up the young; they still mate with others.

2.13 Diversity

Behavior varies across species because the environment they arose in varies, and their evolution history varies. It is hard to extrapolate sex behavior from one species to another in the same genus.

Observing the behavior of other animals cannot tell us what we are like. Pointing out how some species behave, and claiming humans are likely to be also that way, is a weak conclusion, since counter-examples can always be dredged up. Even in the living genus closest to us, the Pan, the two species differ in how they generally behave and are organized socially. There is no standard Pan behavior, or great ape behavior, or primate behavior, or mammalian behavior, or vertebrate behavior, or animal behavior, when it comes to either sex or societies.

3 The human sex want

I now turn to the human sex drive. I will analyze it by looking at the major theories and verified facts about sexual behavior collected over the years. The quotes from the seminal books are those the heavyweight authors do not modify or refute elsewhere.

· Sigmund Freud: The first significant scientific analysis of sex, especially the female pleasure, came from Freud who thought ability to orgasm was a sign of a mentally mature woman.
· Dr. Alfred Kinsey: This Indiana University professor took the next major step with surveys in the late 1940s, resulting in two published books, one each on male and female sex behavior.
· Masters and Johnson: William H. Masters and his later wife, Virginia Johnson, recorded, researched, and wrote about the actual physical nature of the male and female orgasm among an experimental group in the mid 1960s.
· Mary Jane Sherfey: All the previous works were precise, detailed, and popular, but heavy on medical jargon making them hard to read. Sherfey added a primer on anatomy and a psychoanalytic interpretation of the Masters and Johnson data in a small paperback, published in the second half of the 1960s.
· Dr. Seymour Fisher: In the early 70s, Fisher, a psychologist, conducted a survey of women's experiences during orgasm and reported the results and some case histories in a massive report, and then condensed it into another paperback.
· Shere Hite: surveyed over 3000 women, and summarized the responses in a popular book which sold about 50 million copies.
· Helen Singer Kaplan: a founder of the field of sex therapy, and a clinical professor of psychiatry at NY Hospital-Cornell Medical center, would write a detailed book, on a new therapy to treat sexual dysfunctions.
· Donald Symons: one of those who seeded EP. Originally an anthropologist, his evolutionist look at sexuality is a classic of the field.
· Elisabeth A. Lloyd: The books mentioned earlier started the study of human sexual behavior. I also quote from a recent book from Lloyd which summarizes newer studies and surveys, mainly to show the original work has stood the test of time; the results now do not vary significantly from those thirty plus years

ago.

There is almost limitless data on sex, both human and animal. Mostly the quality is questionable. I will try to summarize what is known on the research side, relying on a similar try recently by the director of the Kinsey Research Institute. For biological details, it is best to refer to standard texts. The studies and surveys of sex are often inconsistent, conducted on small samples, and not at the level of other sociological surveys. They are oftentimes poorly funded, agenda-driven, and biased by how the public currently perceives sex.[17] The data collected here should not be considered established scientific fact. Instead they should be used to see why the way serious research in sex is headed, new data are unlikely to aid in objecting to the view presented later.

John Bancroft, former director of the Kinsey Institute for Research in Sex, Gender and Reproduction at Indiana University and Clinical Professor of Psychiatry at Indiana, summarizes the state of the field.[18] Bancroft, a Cambridge alum, is the most prominent researcher devoted to the field. The top ten universities in medicine, biology, or psychology, do not do sexology. Some research is done under the umbrella of urology.

While the book is comprehensive, he is forced to include many papers from lightweight journals, failing to emphasize the difference in credibility between contradicting studies. On issues such as the G-spot and testosterone, the book presents all the papers, from journals of varying quality, measured by the standard rankings from the journal citation reports. I will look at medical texts on anatomy and gynecology to dig deeper into the biological details. For studies, surveys and the general direction of sexology, Bancroft's will be the reference.

3.1 Anatomy

Mary Jane Sherfey's *The nature and evolution of female sexuality*, 1973, clearly describes sex organ anatomy. I will follow that description, adding details discovered in the last decade. Many of these are about the relative size of the various structures.

The main male sex organ is the **penis**, with a bulb called the **glans**, at the tip, and a **shaft**. Inside the shaft are two cavities, the **corpora cavernosa**, and a third sponge-like body called the **corpus spongiosum**. These run the length of the penis and fill with blood during erection. The shaft is covered by the **shaft skin**, and the bulb by the foreskin with the technical name the **prepuce**. At the base of the penis, the corpora cavernosa fork into two roots, the **crura**. There is one final structure, the **bulb of the penis** at its base close to the **scrotum**, the last colloquially known as the ball sac.

Anatomically, the female sex organs are equivalent to the male ones, but positioned mostly inside the body. For women, the central sex organ is the **clitoris**, the homologue of the penis. It has a bulb at the tip projecting in front of the vaginal opening, almost where the male penis is. The bulb is covered by a retractable fold of skin, the **clitoral hood**. Inside the body, the bulb extends into the **clitoral shaft**, which forks into two roots, the crura, even deeper in. In women the spongiosum surrounds the urethra and the vaginal wall, in front. There are two bulbs, called the **vestibular bulbs**. As in men, during arousal, all these cavities fill with blood. These structures lie the other side of the vaginal wall, inside the body. Only the clitoral hood and bulb are external.

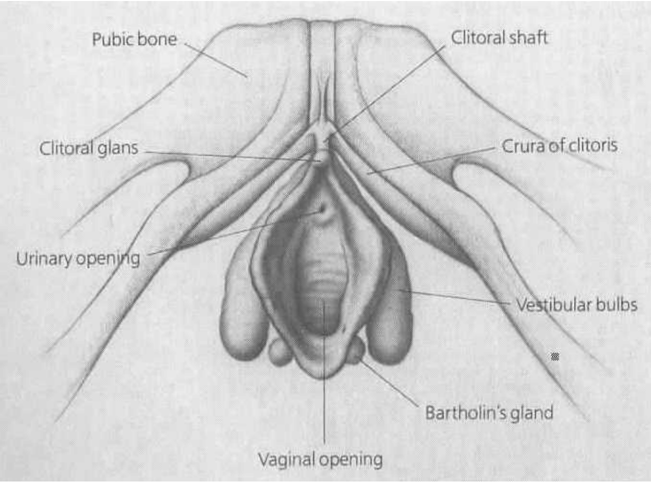


Figure 3.1: Clitoral anatomy

Surrounding the vaginal opening are the inner lips, **labia minora**, and around it the outer lips, the **labia majora**. The **perineum** is the skin below and behind the vaginal opening, and is the same in both men and women. These are external. There are various ligaments anchoring the organs, and muscles which contract during orgasm. The nerves and blood vessels, arteries, capillaries and veins, are mostly the same in men and women. The **pudendal nerve** and its branch, the **perineal nerve**, are the major nerves which generate feelings of touch, warmth, pain and pressure in this area. The nerves branch off into tiny nerve endings at the tip. The clitoral hood in women, and the foreskin in men, have several endings called genital corpuscles sensing the pleasure of touch. The ones in the clitoral glans—tactile corpuscles, pacinian corpuscles and free nerve endings—sense pressure and vibration. The vaginal wall has few, and is mostly insensitive to both touch and pain. It does have vegetative or visceral nerves which trigger diffuse and imprecise sensation. Pain sensed by such nerves, visceral pain, is often felt as coming from elsewhere. The vaginal opening, the introitus, is supplied by the deep perineal nerve, is touch sensitive and can feel the first penetration.

Some of the organs are connected via ligaments or muscles to other muscles such as the rectal ones. In women, penetrating from behind excites the sex organs slightly through this route. In men, the prostate gland is located close to the rectum, and is sensitive to touch.

Table 3.1 Homologous sex organs

Men	Women
penis	clitoris
penile head (bulb or glans)	clitoral bulb (glans)
2 corpora cavernosa inside shaft	fused clitoral shaft
2 crura (roots)	2 crura inside a membrane
corpus spongiosum	spongiosum, front of vaginal wall
fused penis bulb	vestibular bulbs, front of the wall
foreskin	clitoral hood
shaft skin	labia minora, the inner lips
shaft sheath	vaginal wall

Table 3.1 Homologous sex organs (*continued*)

Men	Women
scrotum skin, around the balls	labia majora, the outer lips
testes (balls)	ovaries

The widely discussed G-spot tissue has fired the popular imagination for a long time. Hite, in her introduction to the *The Hite Report*, 2004 (originally published in 1976), states:

> One of the reasons this misunderstanding [that plain intercourse is enough for orgasm] still exists is the invention of the mythical g-spot just a few years after *The Hite Report* was published [1976]. The idea that women have a special spot inside the vagina that can cause orgasm if stimulated in the proper way became popular in the 1980's when three clinical researchers published a book based on scanty research claiming just that. They did not explain why this spot had never been identified before and why there was little evidence to support its existence . . . Between 1999 and 2001, research in several countries effectively demonstrated that no such spot exists.

The G-spot has no analog for men, unlike the clit being the homologue of the penis. Research has shown only the clit can get stimulated and reach orgasm, not the Skene's glands located at the G. This gland is the homologue of the prostate but smaller, harder to reach, and difficult to stimulate. So the popular and unscientific deep vaginal pleasure at best is slight clitoral stimulation. After Hite's latest publication, it has been resurrected as prostate-like small glands in the corpus spongiosum around the urethra and vaginal wall (Rebecca Chalker, *The Clitoral Truth*, 2002, p. 43). But since it is still not on the wall itself, how penetrating the vagina easily stimulates it remains unexplained. The popularity of the spot, from lightweight studies and populist articles, against what serious science has discovered, shows how much we mix fact and fancy when it comes to sex. The classic human anatomy text, *Gray's Anatomy*, does not mention the G.[19] Books which do mention it add the rider it is supported largely by papers in non-peer-reviewed journals, and seemingly found only in some women. Credible sex therapists such as Kaplan and Bancroft mention treating anorgasmic women by getting them to gently stimulate the clitoris, not the G-spot.

3.2 Physiology

Masters and Johnson observed and explained the physiology of orgasm, in *Human Sexual Response*, in 1966. It is also the last time anybody so meticulously recorded the orgasm.

M&J, as I will call the authors, divide the female response into four stages:

1. Excitement:
   - nipples get erect
   - veins in the breast stand out
   - outer lips thin out and flatten
   - the vagina close to the uterus expands and lengthens
   - the vagina gets lubricated by moisture seeping in through walls from the encircling blood vessels
   - the uterus is pushed up
2. Plateau:
   - breasts increase in size
   - a flush called the sex flush appears mostly over the lower body of very fair-skinned women
   - some muscles in hands and feet tense up (myotonia)
   - breathing and heart rates go up (hyperventilation and tachycardia)
   - the inner lips redden (the sex-skin reaction)
   - the Bartholin's glands located behind the vaginal wall close to the opening produce a few drops of mucus which lubricate the wall
   - clitoris gets engorged with blood, the shaft straightens, the bulb draws back and becomes harder to see from the outside
   - the vaginal walls turn purple from increased blood flow (vascocongestion)
3. Orgasm:
   - rectum muscles contract
   - muscle tensing and the sex flush peak, and arm, leg and neck muscles may spasm

  - muscles of the vagina close to the opening contract strongly in a pattern repeated a few times at 0.8 second intervals
  - uterus contracts irregularly
4. Resolution: all changes are reversed.

Women can move from stage 3 to stage 2 and back multiple times. Some can do this so fast it appears they have one long continuous orgasm lasting up to a minute, a reaction termed *status orgasmus*. Most reactions are not guaranteed in every case. The inner lips always go pink or red before an orgasm, and the vaginal muscles always pulsate during the climax.

Male orgasm is similarly sequenced, but there is a refractory period after males ejaculate, when they cannot get erect again.

With that as the introduction, I will now analyze the sex want deeper. Starting with the growth phase. Then looking closer at the physiology, including genitals, arousal, erection and orgasm. Followed by a section on how sex desire develops, how it is tied to cultural mores, effects of ageing, and variant and problematic sexuality. Bancroft's book is the guide. The studies quoted there do not differentiate between innate and learned parts of the sex drive. In the rest of this chapter, neither will we. The sections that follow describe how sex and sexuality work in our current societies, largely those of the West.

3.3 Bancroft's overall view

Bancroft uses the dual-control theory developed at the Kinsey Institute as his theoretical base. This posits sex attraction and arousal are driven by both positive (excitatory) and negative (inhibiting) elements. He discusses two other theories—the SST (Sexual Selection Strategy) theory of EP and the scripting theory of sexual interaction. We will see EP in detail in later chapters, it being one of the major science branches explaining behavior, including but beyond sex. Scripting theory is, per Bancroft, an untested hypothesis, and hence of little interest. It is built heavily on social learning.

The model that explains the female drive, used in the book and presumably the trend in serious sexology, is far from the politically correct version. Women's sexuality is seen as a three-part one: 1. A basic pattern, 2. A super-added pattern, and 3. A socio-cultural aspect.

3.3.1 The basic pattern

Pages 131 through 134 of Bancroft must rate as the second most sensitive take on the female sex drive, the founders of EP contributing the first. Insensitive, from a different point of view.

Bancroft considers the reproductive part of the female response the basic pattern, to be found in most women, and hence species-typical. This is the vagina responding by preparing for insertion and thrusting, unrelated to arousal or pleasure. This has three parts —pain sensitivity reducing, more blood automatically flowing to the vagina, and the vagina mechanically getting lubricated.

3.3.1.1 Analgesic effect of vaginal stimulation

Pressing on the front vaginal wall or the deep end, the cervix, increases the pain threshold. Pain, such as a pinprick on a finger, is felt less. This was seen first in female rats, and is now known to occur in women too.[20] In rats, the pain-blocking effect of penile intromission has been estimated to be at least five times greater than a standard dose of the pain-killer, morphine. In women, the effect is controlled at least partly by the sensory fibers of the vagus nerve, with the pelvic and hypogastric nerves also probably playing a part. The analgesia is not related to the level of arousal. It is a reflex. Sexual arousal is not required to trigger it.

3.3.1.2 Vaginal blood flow and lubrication

More blood flows to the vagina even with negatively evaluated sexual stimuli, and it is hence another reflex. Laan and Evereard hypothesized VBF was an automatized response mechanism.[21] To quote, from p. 132: "There is 'automatic' lubrication of the vagina, which, the evidence from women suggests, occurs to some extent in the presence of any potential sexual stimulus, whether appealing or not." This lubrication is moisture seeping in from the blood in the surrounding vessels. Hence vaginal blood flow is rising automatically.

3.3.2 The super-added pattern

The super-added pattern is the part of the female response not concerned with reproducing, and hence likely an evolutionary byproduct of the male reproductive mechanism (Bancroft's words). To quote:

> We have already considered the possible functions of the female orgasm and have failed to find any evidence that, as claimed by evolutionary 'adaptationists', it increases the likelihood of conception. In any case, the available evidence indicates that for the majority of women vaginal penetration alone is not sufficient to elicit orgasm; some form of additional clitoral stimulation is required. Yet the anatomy of the female does not appear to be designed to lead to clitoral stimulation from vaginal penetration.
> There is also no evidence that the experience of clitoral erotic pleasure enhances fertility.

3.3.3 The socio-cultural aspect

Bancroft thinks women's sexuality is genetically more influenced by socio-cultural learning. Specifically, that it is easier to inhibit by teaching. Unfortunately, cultures where the super-added pattern does not dominate, do not teach women to suppress that pattern. They teach women nothing sexually. In these cultures, the super-added pattern is absent not from negative teaching, but from not being positively reinforced.

3.3.4 The theory

The female drive is defined referring to the male one of erection and ejaculation. While the earliest notion that the two are exactly equal has largely retreated, the physical female drive is still seen as being the clitoral response and orgasm. Anything automatic may be part of it, but cannot be the sole part. By the popular ideas, women who show only the basic pattern—content with automatic lowered pain sensitivity, more blood to the vagina, and a moist vagina —do not have a physical sex drive. We will see later this has been the recurring idea of social mores: the super-added pattern is not species-typical, but almost all women can be taught to enjoy it, and so society should train men to modify their basic act to adjust to women's superadded one.

Sexologists from Kaplan to Bancroft have been unable to see the female drive as purely innate. The animal models from rats to primates, including our closest species, bonobos and chimps, show female basic behavior as lordosis or presentation gestures, not as an arousal drive.[22] The physical changes associated with such behavior, analgesia, VBF and lubrication, are conserved in humans. The hopping and darting behavior of the female rat to attract a male rat is at best a receptive drive, for it is shown only when the male displays sexual interest.[23]

The basic response of females, conserved across the orders primates and rodents, is an automatic reflex to mounting and penile intromission. Women have the capacity for specific clitoral pleasure, divorced from conceiving.

3.4 Sex differences in growth

There are three main stages of growth as related to sex and reproduction. The first is prenatal, in the womb. The next is adrenarche in prepubertal boys and girls. The third is the growth at puberty, known as menarche for girls. Adrenarche is largely internal.

3.4.1 The growth stage

After the sperm impregnates the ovum, the two cells become one by their cell membranes' fusing together. The sperm is engulfed by the egg's cytoplasm, and the arrested second meiotic division of the egg completes. After about twelve hours, the nuclear envelopes distintegrate and the DNA fuse to form the first diploid cell, the zygote.

The zygote begins to divide by mitosis, and this is the blastocyst stage. It ends with the blastocyst implanting in the uterine wall, for mammals. The further stages described below are for mammals. The blastocyst is a hollow sphere of a few dozen cells, with the cells on the outside called the trophoblast, and an inner cell mass at one pole. The trophoblast develops into part of the placenta.

Our bodies have mutiple cell types, but almost all with the same nuclear genes. At the very early stages of growth, cells are equipotential, that is they can develop into any cell, but this trait weakens as the embryo develops and differentiates. Also, development is driven by genes and the environment. Every cellular process, including splitting, needs energy from the environment in the form of food nutrients. It also requires several chemicals, ultimately sourced from food, and sometimes sunlight.

In mammals, a part of the Y chromosome coding for H-Y antigen decides whether a fetus ends up male. In humans, at six weeks, the undifferentiated gonad contains structures called primitive sex cords. These continue to grow in the male, and degenerate in the female. The sexes can be told apart by about seven weeks. The gonads, in turn, produce the gonadal hormones. Gender is differentiated primarily by the hormones T and DHT, a version of T which cannot be broken down into E. Female hormones have no major effect. In the absence of T, the fetus will develop female. The organizing function of T is to grow the testes, including seminal vesicles where semen is stored, the vas deferens which is a tube for semen passage, and the prostate gland.

Embryos initially have two ducts called the Mullerian duct and Wolffian duct. The Wolffian ducts provide passage for urine and feces through the urogenital sinus, but eventually develop into the male reproductive organs, degenerating in the female. The Mullerian duct develops into the female reproductive organs: fallopian tubes, uterus and cervix. It degenerates in the male. Testosterone is generated from the interstitial cells of Leydig in the testis by the eighth or ninth week. The Mullerian ducts degenerate influenced by the anti-Mullerian hormone produced inside the testis. Another version of T, DHT, masculinizes the original urogenital sinus and the external genitals. The genitals start as the genital swelling at around four weeks, and become a tubercle by six weeks. Sex differentiation starts at this point. The external penis and the largely internal clitoris (the clitoral cavernosa, crura and the bulbs) develop in males and females. The vagina is more interesting—the lower part close to the opening develops from the urogenital sinus, that is the same tissue as the penis, while the upper part develops from the Mullerian ducts.

For mammals, the testes drive differentiation, and if removed, XY males develop phenotypically and anatomically female. In birds, where females are the heterogametic sex, it is the ovary and estrogens which drive differentiation. Removal of ovaries leads to a WZ female developing as a male.

After birth, major sex-specific changes are largely arrested until puberty. Those of puberty are also driven by hormones, this time both by T and E. The first develops body hair, musculature and deeper voice in men. In women, the second develops breasts and the like. These are the activating functions of the sex hormones. Lack of the right hormone, or its receptors, at either the prenatal, childhood or puberty stages leads to different gender identity problems. Congenital genital hyperplasia is a clinical condition where adrenal glands produce an androgen instead of cortisol, partially masculinizing a female, including enlarging the clitoral bulb and fusing the labia. If treated from birth, the condition is curable with females developing normally. Behaviorally there are some indications such females tend to be tomboyish, but largely fit in. A genetic deficiency in an enzyme, 5 alpha-reductase, reduces DHT synthesis from T, causing the external genitalia of boys to look like that of girls till puberty. At which point male characteristics emerge, influenced by T. These are anatomically men.

Testosterone occurs in three different forms in the blood plasma: about 45% is bound firmly to a protein called SHBG (Sex Hormone Binding Globulin), more than 50% bound loosely to albumin, and the rest free. In men most T is produced in the testes, with small amounts from the adrenal cortex. The T in women mostly comes from the adrenal glands. Other interesting androgens are DHT, a form of T produced from both testes and the adrenal cortex, androstenedione, DHEA (DeHydroEpiAndrosterone) and DHEAS (DHEA sulphate). Women have twice as much DHEA as men, but roughly the same amount of DHEAS. These are produced in both the ovary and the adrenal cortex. These hormones are believed to be connected to the immune system, but have a wide role throughout the body.

Table 3.2 Levels of testosterone: free/total in ng/100mL

	infant	second week	adult
Male	7.2 / 240	1.82 / 260	10 / 500
Female	0.9 / 30	0.21 / 30	0.3 / 30

The male infant has about 240ng/100mL of T, half what the adult has, whereas the female infant has the same amount as an adult female, 30ng/100mL. Of this, 3% is free, in both sexes. Within the first few days after birth, the levels drop dramatically, probably because of the lack of placental hormones. The level of SHBG goes up, and the proportion of free T hence falls to 0.7% in both sexes. Starting in the second or third week after birth, the levels in males climb back to about 260ng/100mL. The adult male has close to 500ng/100mL of T, with 2% free. An adult female has 30ng/100mL, with about 1% free. Total T in men is about 16 times that in women, and free, biologically active, T more than 30 times, on average.

3.4.2 Adrenarche

Around the age of 6 in girls and 8 in boys, the hormones DHEAS and DHEA, and slightly later, androstenedione, get produced more from the adrenal glands. This probably causes the early growth of hair in both sexes. A change found only in humans and the great apes. What triggers it and why are unknown.

3.4.3 Puberty

Puberty starts between 9 and 15.5 years for girls and a bone age of 12 for boys. The mean age varies by culture. Sensors in the hypothalamus and hindbrain monitor whether the body can cope nutritionally with the next stage of growth, and trigger pubertal changes. This explains some of the cross-cultural and individual differences in the age of onset, but not all. The sensors start releasing GnRH, and one gene controlling the GnRH clock is the GPR54 gene. While this is often called the puberty gene, many others are likely to be involved.

In girls, breasts and pubic hair grow thicker between 9 and 13 years. Menarche, the start of menstruation, is between 11.5 and 15.5 years. These are triggered by rising estrogen (E) levels. The first few menstrual cycles happen with no viable egg produced (anovulatory cycles). Breasts and other outward signs the body is sexually mature occur before menarche. This is true only in humans and not in other primates. Androgens cause the labia majora, minora and the clitoris to grow as the embryological homologues of the scrotum and the penis. High doses of external androgens cause an enlarged, overly sensitive clitoris.

Boys see their T levels go up at around age twelve. Rising steeply till 15-17 years, and then slowly till the teens end. The amount of SHBG falls during adolescence. The testis and scrotum develop, and pubic hair thickens, during the span of 9-13.5 years. About a year later, the penis starts to grow, along with the internal seminal vesicles and prostate. Still another year later, they ejaculate for the first time. The growth spurt also leads to the voice breaking and deepening. Androgens promote increased muscle bulk and influence bone growth in ways not totally understood.

3.5 Genital tissue details

The penis and clitoris are similar in men and women, at the tissue level. But the subtle differences significantly affect arousal.

3.5.1 Penis

The penis is the male reproductive organ. It is evolutionarily old, existing in some form even in invertebrates, with birds an exception. Here we focus on the human male penis.

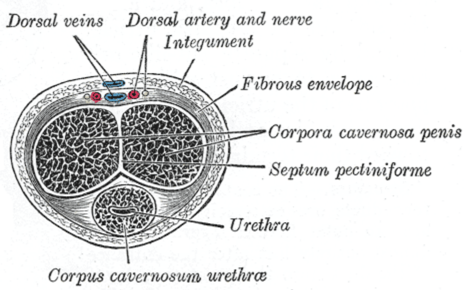


Figure 3.2: Penis anatomy: cross section

3.5.1.1 Corpus Cavernosum

The corpora cavernosa form most of the body of the penis. The two cavernosa lie together, separated by a septum. Each is covered separately by the deep fibers of the tunica albuginea, running circularly. The fibers come together in the middle to form the septum. Nearer to the base of the penis, the division is thick and complete, while toward the glans (the distal end), the separation is incomplete and blood circulates between the two cavernosa. The tunica albuginea, a fibrous sheath, has a second layer covering both cavernosa together. These are called the superficial fibers and they run

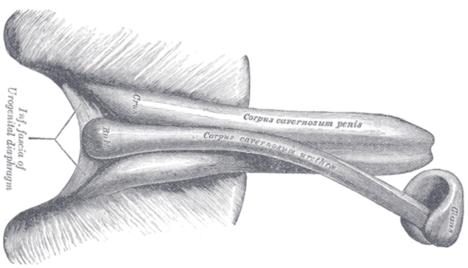


Figure 3.3: Penis anatomy

length-wise. The tunica albuginea of the cavernosa is hence double layered. Both cavernosa are supplied blood by the cavernosal artery and a branch of the dorsal artery of the penis. They are drained by the deep dorsal vein. The cavernosa are criss-crossed in all directions by the trabeculae—a set of vessels, autonomous nerves, and smooth muscles.

3.5.1.2 Corpus Spongiosum

Corpus cavernosum urethra is now called the corpus spongiosum. It surrounds the urethra, the small tube through which both semen and urine come out. It lies behind the cavernosa. The tissue is not erectile, and the organ acts like a sponge. Two arteries, the artery of the bulb of the penis and the dorsal artery, supply it blood, with the deep dorsal vein draining it. The spongiosum has a tunica albuginae sheath which is thinner and more elastic, and formed partly by smooth muscle cells.

3.5.1.3 Glans

The glans is the distal end of the spongiosum. The glans projects over the end of the cavernosa. The base of the glans is the corona glandis, attached to the neck of the penis. Small preputial glands in the corona and neck secrete smegma, which deposits as a white substance. The glans is supplied blood by the dorsal artery of the penis, and is drained by the deep dorsal vein. There are nerve endings carrying the sense of pressure and vibration, via the pudendal nerve. The organ senses touch weakly.

3.5.1.4 The crura

The crura, singular crus, are the root of the cavernosa. They are attached to the pubic bone, and covered by the ischiocavernosus muscle. The two roots come together to form the body of the corpus cavernosum.

3.5.1.5 Bulbs

The bulb of the penis is the beginning section of the spongiosum. It lies between the crura, and is connected firmly to the perineal membrane. The bulbospongiosus muscle covers it. The blood supply is from the artery of the bulb of the penis.

3.5.1.6 The sheaths

We saw a fibrous sheath, the tunica albuginea, surrounds the cavernosa and spongiosum separately. The cavernosa and spongiosum are together covered by another sheath, the Buck's fascia. This is then covered by a muscular layer, the Dartos fascia, which is covered by penile skin. There is a rich layer of veins, the subalbugineal venous plexus, between the erectile tissue of the cavernosa and the tunica. The deep dorsal vein runs between the tunica and Buck's fascia. The superficial dorsal vein, which drains the penile skin, lies outside the Buck's fascia.

3.5.1.7 Skin

Penile skin is divided into shaft skin, covering the body, and the prepuce, covering the glans. The tip of the prepuce is richly innervated by the pundendal nerve. Cutaneous sensitivity is greatest in the region over the glans penis. The shaft skin receives nerves from the same source, but is less touch sensitive. The dorsal artery of the penis supplies blood to the skin, by passing through the dartos layer. The drainage is via a separate vein, the superficial dorsal vein.

3.5.2 Clitoris

The clitoris is the embryological homologue of the penis, that is the same tissue which develops into the penis in men develops into the clitoris in women. But the structure is different. The cavernosa and the spongiosum are separated and not placed together as in the penis. There is hence no outer sheath or skin surrounding the cavernosum, spongiosum and urethra. The glans is much smaller.

3.5.2.1 Clitoral cavernosa

The clitoral cavernosa is what many used to refer to as the clitoris. It consists of the glans visible from the outside, the shaft or body preceding it, angled to the topside, and the root or crura which bends downward from the top of the shaft. There are two crura forking out from the base of the shaft.

The clitoral glans is similar to the penile one, but much smaller. It has the same number of nerve endings, mostly Raffini and Pacini corpuscles, sensing pressure and vibration. Since the glans is smaller, the density of nerve endings is higher than in the penis.

The body consists of two cavernosal bodies fused at the midline. The two cavernosal bodies each have a sheath, with one additional sheath covering both. This is the tunica albuginae. The tissue is erectile as in the penis. The clitoral crura are the attached roots, similar to the penile crura. They are covered by the ischiocavernosus muscle.

3.5.2.2 Spongiosum

The spongiosum does not exist as a separate structure in women. There is erectile tissue around the urethra which may be considered the homolog.

3.5.2.3 Vestibular bulbs

The single fused penile bulb in men becomes two separate vestibular bulbs in women. They are about 3 cm long, and flank the vaginal orifice. They unite at one end to form the pars intermedia, and are connected to the clitoris by two slender bands of erectile tissue. The bulbospongiosus muscles cover the bulbs, as in men, but each bulb is covered separately.

3.5.2.4 The sheaths

The tunica albuginea sheath covers the cavernosa, as in men. Unlike in the penis, there is no Buck's fascia, Dartos layer, or outer skin. The homologue of the skin would be the labia and the prepuce over the clitoral glans, but these are outside the body. There is no subalbugineal venous plexus inside the cavernosa either.

3.5.3 The vagina

The vagina extends from the opening to the uterus. It gets wider as it goes up from the opening. Above the level of the hymen, the surfaces of the wall are in contact, that is collapsed together, forming a transverse slit. The front (anterior) wall is typically 7.5 cm long and the posterior wall 9 cm long. The inner layer of the wall is mucosal. Outer part, smooth muscle in two layers. The inner layer is circular fibers and the outer, thick lengthwise fibers. The middle of the vagina is enclosed in a U-shaped muscular sling, the pubo-vaginalis. The lower vagina is surrounded by the muscle fibers of the bulbospongiosus. Incidentally, the part closer to the opening is called lower, outer, or distal. With the other part often termed upper, inner, or proximal.

The wall is lubricated continuously by the fluid transudate from the lamina propria (mucous membrane) and mucus from the cervical glans. The cervix is the portion near the uterus.

Blood is supplied by the internal iliac artery, and this is separate from the clitoral supply. Drainage is by a separate vein, the vaginal vein. The lower vagina is supplied by the somatic pundendal nerve, and is touch sensitive near its opening. The upper vagina is supplied by the autonomic splanchnic nerves, which do not provide touch sensation. Another autonomic nerve, the vagus nerve, which does not pass through the spinal cord, also innervates the vagina.

3.6 Arousal

Arousal is the physical change indicating a person is ready for sex. In men this is largely seen as the penis rising. In women, as we saw before, the basic pattern is a reflex, while the super-added one is the labia and clitoris responding. We will detail the erection response in the next section. Here we will explore what causes arousal, along with its neurological basis, that is how the brain converts sensory input into sexual arousal.

3.6.1 Sexual stimuli

The main forms of sexual stimuli, apart from fantasy, are the sensory stimuli. For humans, seeing and touching are the most important sensory modes for sex arousal, with smell playing a smaller role.

3.6.1.1 Visual

Moving erotic images elicit more sexual responses in men than static ones. In general, they are more aroused by visual stimuli than women. We will discuss visual stimuli more in the next chapter, since EP covers them extensively.

3.6.1.2 Smell

In humans, Bancroft points out the organ that processes pheromone signals, the VNO (Vomero Nasal Organ), is present. However, as we will see in Section 4.6.3 on page 156, the VNO is nonfunctional in our species. We have no pheromone system.

Smell, processed by the conscious brain, does affect sexual attraction. Perfumes and deodorants have a long history. While they are sometimes used to mask odors, that does not totally account for how popular perfumes are, especially in women, who have fewer sweat (sebaceous) glands than men. Quite a few of the surveys on what odors men and women prefer are done by companies developing perfumes. The studies Bancroft mentions show inconsistent results. Only the vague statement that smell also plays a role in sexual attraction can be maintained.

3.6.1.3 Touch

The role of touch in the sex response of men and women is obvious. Erotically touching the genitalia is sensed and conveyed to the brain by the dorsal nerve of the penis. Touch and pressure receptors are found in the genital skin and glans of both men and women. Touching other parts of the body can also be erotic. Sensitivity varies across the body, with the finger tips being the most sensitive. We will analyze the sensation of touch at the end, in the appendix sections on neuroscience. Its details are largely noncontroversial, and driven mostly by biology.

3.6.2 Cognitive model of arousal

The model of arousal used in sexology has two parts—the automatic, preattentive, reaction to a stimulus, and the controlled, conscious, attending to the object of desire. Studies on automatic processing, however, tend to mix sex responses with general responses to exciting events. They seem to indicate the automatic part is an enhanced state of being prepared to act in some way.

The studies in women have largely used VPA to check arousal, and Bancroft questions how valid the data are [24] The photometer used shines red light into the vaginal wall and measures how much light is reflected back. How intense a pulse of blood is, affects how much light gets reflected back. How it does this is not clearly known. VPA is affected by changes in the general blood circulation. If one places a photometer on the finger, and raises the finger, a large pulse amplitude is registered. There is also no absolute unit for measuring VPA, so the numbers can only be related to other values in the same experiment.

3.6.2.1 Subliminal priming

Subliminal priming is where a stimulus, such as a picture, is shown for just a few milliseconds so that the visual regions of the brain register it, but conscious awareness does not. The one study on subliminal priming with sexual stimuli found an inhibiting effect, though it was interpreted differently. This cannot be easily explained.

3.6.2.2 Effects of distraction

Being distracted impairs erections in normal men, but not those with dysfunctions. The first is no surprise. For the second, one explanation is that the mind is distracted off even more negative thoughts inhibiting erection, contributing to the original dysfunction. In women, distraction reduced VPA. At the end of the experiment, women recalled they were aroused less, but during the experiment, in real-time, they reported the same arousal as without distraction. The real-time, continuous, assessment seemed to depend less on the actual genital response in women.

3.6.2.3 Effects of wrong feedback

When men were given a placebo which they were told would reduce their sex response, most actually had decreased arousal. Similar was the result with a pill which increased the response. In another experiment, men were shown an erotic film, and later told falsely their response was less than average. Some were told this was because the film was poor, and others because they were not the type to be aroused in a lab setting. When another erotic movie was shown, the first group showed more genital response and thought they responded better, than the second group.

3.6.3 Brain imaging

The ACC (Anterior Cingulate Cortex) is known to respond to visual sexual stimuli, that is nude pictures or movies. ACC has two divisions—the rostral (toward the nose) division connected to the amygdala and the hypothalamus, and the caudal (toward the tail) division involved in resolving conflicts caused by different decisions made in separate brain regions. The rostral division is more emotional, and the caudal related to self-control. Another part, the basal ganglion, is also known to respond in humans; in macaque monkeys stimulating this evokes erections. Temporal lobes and the MOFC (Medial OrbitoFrontal Cortex), parts of the conscious brain, are deactivated in some studies. It is unclear how much of this processing is sexual, and how much just generic visual.

Most of the data are from males. In women, seemingly the thalamus, hypothalamus and amygdala are less strongly activated, with some studies showing the first two staying inactive. The difference in activating the thalamus has not been consistent across studies, while the other two do seem dimorphic. The amygdala and the hypothalamus are both larger (after adjusting for larger body size) in men. These regions are evolutionarily ancient. The dopamine reward system, involving the ventral striatum, the VTA, and the dorsal caudate nuclei were activated in many studies in both men and women. These parts code for learned pleasures, both biological and psychological.

3.6.4 Conditioning

The studies on conditioning, both classical and operant, with respect to sexual stimuli are inconsistent. In this context, classical conditioning is where an external stimulus, say the ringing of a bell, is taught to be associated with a sexual stimulus. Operant conditioning is more complex associational learning. Bancroft shows neither type has been demonstrated in humans, connected with sex. Habituation, where a person responds less to the same stimulus repeated over and over, has not been demonstrated either.

Here, the drawbacks of lab studies become obvious. Rewarding a stimulus, that is allowing mating with the person in the photo or film, is considered unethical. The conditioning paradigm of the lab hence does not approach that of the real world, where how a person continues to respond might vary when the attraction is rewarded with sex. The Coolidge effect, where men get bored and seek new mating partners, has been demonstrated in both human surveys and lab tests of many mammals.

3.6.5 Mood

Mood is another issue where lab studies show conflicting results. Many studies have found negative mood lowering sex desire. Some studies showed anxious or fearful men feeling more desire. Bancroft calls this excitation transfer, converting general arousal into specific desire. One study concluded women's sexual feelings vary across the cycle partly from changes in general well-being. Self-reported interest peaked most commonly in the post-menstrual week.

3.6.6 Sex hormones

Hormones work complexly to arouse us. Most of them control more than one of desire, erection, orgasm, and satiation.

3.6.6.1 Androgens

The role of androgens, particularly T, in the male drive is well documented. They are involved at every stage. Castrated men, who lose T-producing gonads, largely lose their drive since the little produced from the adrenals cannot compensate. They would still remember the pleasure since memories stay intact. They would hence know the loss of a pleasure. Men with T knocked out cannot copulate and reproduce. Testosterone is central to the innate male desire. However arbitrarily increasing its level does not increase desire, since T has other, anabolic, effects on the body, and there are likely to be threshold levels. Estrogens reduce men's sex drive.

Testosterone is known to affect erection directly by helping synthesize Nitric Oxide Synthase, which helps produce Nitric Oxide dilating the arteries. There are androgen receptors on the smooth muscle tissue of the penile cavernosa. This has been shown in rats, rabbits, dogs and other mammals but, so far, not in men. The uncertainty is because the sacrifice-and-dissect method used for mammals cannot be used with humans.

For women, Bancroft ambivalently concludes T affects only some. Specifically the ones who exhibit the super-added pattern, and not just the basic one. By how the culture defines the physical sex drive, women who exhibit the basic pattern have none. That T does not affect them is unsurprising. The data Bancroft presents shows women with the super-added pattern do respond to T.

3.6.6.2 Dopamine

Dopamine is known to enhance male sexual behavior. Three different brain systems which use DA to signal may be involved. The nigro-striatal brain tract, from the substantia nigra to the dorsal striatum of the basal ganglia, initiates the motor response of copulation. In humans, the thrusting is probably learned, unlike in rats. The meso-limbic tract, from the ventral tegmentum to the ventral striatum (the emotional brain), is involved in incentive motivation. Third, the sexually dimorphic MPOA has DA input from the A14 periventricular system. The MPOA controls mounting and thrusting in rats, and activates when men copulate as well. The effect on women is less understood theoretically. Practically, DA agonists (molecules which activate the same receptors) such as l-dopa (precisely a precursor to dopamine) and apomorphine nauseate humans, masking any sexual effect they have.

3.6.6.3 Norepinephrine

The hormone NE (called Noradrenaline outside the US) contributes to general arousal in the brain. Switching off the inhibitory signals from the locus coreleus is likely how it acts, especially during REM sleep leading to the normal automatic night-time erection, NPT (Nocturnal Penile Tumescence). Alpha-2 antagonists which increase NE by blocking its reuptake at synapses, better sexual function in men. Yohimbine is one such antagonist, but it has anxiety as a side-effect.

In women, subjective ratings of sexual arousal corresponded to levels of NE in urine, in an old study. General arousal, not necessarily sexual, is controlled partly by NE. Bancroft believes females, less aware of genital changes, are apt to think of general arousal as sexual.[25] In other words, a larger part of the reported female response in studies is general, non-specific, arousal. Levi's study, on NE in urine, has not been replicated, but Bancroft considers it relevant.

3.6.6.4 Serotonin

Serotonin (5HT) is known to inhibit the response. In rats it acts on the lateral hypothalamus, where, following ejaculation, 5HT levels go up. It also acts on the nucleus paragigatocellularis of the medulla, which via descending nerves using serotonin signalling to the lumbar and sacral part of the spinal cord, inhibits erection. In Bancroft's dual-control model, 5HT is the inhibiting hormone.

3.6.6.5 Oxytocin

Stimulating the vagina of a female rat releases OT, which likely contributes to the analgesic effect. It also promotes lordosis, apparently by priming progesterone. How OT affects human sex is uncertain for both males and females. After orgasm it increases, but this may be from the contractions of orgasm than an emotional effect. After all, OT is best known for facilitating the contractions of birthing. Bancroft does not believe its relevance to pair-bonding in humans is established either, despite people labeling it the love hormone [26]

3.6.6.6 Beta-endorphin

Beta-endorphin is an internally produced, endogenous, opiate, similar to morphine and heroin. In some regions of the brain, specifically the MPOA and amygdala, it inhibits sex. In others such as the VTA, it facilitates sex. The inhibition appears to be dose-dependent, with lower levels working to improve the response. Opiate hormones are believed to be linked to the feeling of pleasure, for obvious reasons.

3.6.6.7 Prolactin

Prolactin is a peptide hormone, primarily involved in lactation. It has a number of functions in the body. Increased prolactin inhibits the response. While one study suggested the increase in PRL after orgasm was related to feeling done (satiety), Bancroft does not accept this. The increase was the same in men and women though their refractory periods differ.[27] Bancroft believes the rise in PRL was a side effect of the increase in OT, since OT facilitates producing PRL.[28]

3.6.6.8 Melanocortin

Melanocortin is primarily involved with regulating body fat. And deciding skin color by acting on melanin. There are five different receptors for the hormone, of which MCR-4 (MelanoCortin Receptor 4) is found in the PVN (Para Ventricular Nucleus) of the Hypothalamus. This region is connected to the brain stem, and processes low-level signals in the hypothalamus.

Injected alpha-MSH (Melanocyte Stimulating Hormone) makes male rats get erect more often. It also causes female rats to hop and dart more, along with trying to mount. In humans, one study showed the hormone, a copy called PT 141, Bremelanotide, improving erections in men, somewhat unsurprising since the physiology of erection is similar. In women with impaired sexual arousal, a study by the same sexologists found the women reporting being more aroused, but the actual physical marker tested, VPA, showed no changes. Bancroft leaves the discussion at that point. What he fails to mention is the studies in humans were led by a company, Palatin Technologies (hence the PT). They conducted stage II clinical testing of the drug, but the FDA did not approve the third stage. The agency was concerned about how effective the drug was and why it pushed blood pressure up 3 mm, and wanted the company to refocus on developing the drug as a secondary treatment for those not responding to PDE-5 inhibitors such as sildenafil (Viagra). The company put the drug on hold. Investors do not believe the product is set to succeed, and the stock (traded under ticker symbol PTN on the New York stock exchange) closed at 36 cents on September 18th, 2009, two years after the FDA decision. The likely market size for the product is probably not what the investors are concerned about, it has to be its efficacy and safety. And this is the male version, for those with erectile difficulties or diabetes.

The receptor MCR-4 is found in the Ruffini nerve endings of the glans of the penis and clitoris. These stretch-receptors are associated with arousal.

Note that mice lacking MCR-4, Mc4r-null mice, still copulate and reproduce, though less efficiently. Experimenters were able to establish a colony of such mice. While alpha-MSH influences sexual desire, it is not the central hormone of innate desire.

3.7 Erection

Erection is the genital response associated with sexual arousal.

3.7.1 Men

In men, the penis balloons up with arousal, becomes rigid, and goes up. The scrotal sac also elevates. The changes are from increased blood flow, and blocking of the return of blood via the veins.

3.7.1.1 The vascular system

On sexual stimulation, neural signals relax the smooth muscles of the arteries and arterioles in the cavernosum and spongiosum. They also dilate the arteries, increasing penile blood flow many orders. This causes the cavernosum and spongiosum to fill with blood. When the cavernosum fills and expands, the subtunical venous plexus is pressed against the tunica albuginea, compressing the veins, which are thin walled. In addition, the deep dorsal vein also probably gets pressed against Buck's fascia, leading to it getting pinched off. The return flow of blood is hence blocked. More blood builds up in the erectile tissues. The hydraulic effect causes the entire penis to rise.

Self stimulation or intercourse also triggers a reflex, the bulbocavernosus reflex, in which the ischiocavernosus muscle forcefully compresses the base of the blood-filled cavernosa. The blood inflow and outflow both cease, and the penis hardens. This is the phase of rigid erection.[29].

3.7.1.2 The neural system

The penis has both autonomic and somatic nerves. Somatic nerves control voluntary and partly voluntary muscles (the efferent or motor nerves), and the senses of stimuli (the afferent or sensory nerves). The autonomic nerves control involuntary (striated) muscles. In the pelvis, the cavernous nerves are the main autonomic nerves, entering the cavernosa, spongiosum and glans. The somatic nerve is the pudendal nerve, with sensory endings in the glans and skin. Motor nerves of the pudendal control the ischiocavernosus and bulbospongiosus muscles.

Nitric oxide is the neurotransmitter which the nerves use to dilate arteries. It starts a chain of events blocking incoming calcium channels, dropping calcium concentration inside cells, and relaxing smooth muscles. When smooth muscles relax, arteries dilate, increasing blood flow.

3.7.1.3 The muscular system

The main muscles of erection are the ischiocavernosus and bulbospongiosus. During erection, in men, the middle fibers of the bulbospongiosus compress the erectile tissue of the bulb, while the front fibers compress the dorsal vein to prevent outflow. The ischiocavernosus act together to stabilize the erect penis.

The other muscles involved are the voluntary muscles of the perineum, and the levator ani consisting mostly of the pubococcygeus muscles (pubic to coccyx, or tail, muscle). These are striated, voluntary, muscles, with some involuntary movements as well.

3.7.1.4 Viagra

Viagra is the chemical sildenafil, a PDE5 (PhosphoDiEsterase-5) inhibitor. An erection develops when the smooth muscles of the cavernosum relax. This depends on the level of calcium inside the muscle cells. When calcium levels fall, smooth muscles relax, dilating arteries and increasing blood flow. The chemical CGMP helps reduce intracellular calcium. This chemical is broken down by PDE 5. So inhibiting PDE 5 leads to CGMP buildup, lowered calcium levels, and vessels dilating. Normally, CGMP is released in response to Nitric Oxide signalling from the nerves.

The blue pill, as per FDA guidelines, is to treat erectile dysfunction. In that role, its action is based on credible science. It is not meant to be used to keep an erection longer in otherwise normal men. Evolution's sieve has designed the reproductive parts of sex so finely, claims of improving it need to be viewed skeptically. Improving our basic biology is possible, but unlikely in the short or even medium term. Natural selection has acted for a long time to fashion our reproductive mechanism. In about every higher species, males need to get erect and ejaculate to reproduce. Selection would hence have optimized the mechanics of arousal.

3.7.2 Women

Arteries dilate from arousal the same in women and men. The cavernosa and bulbs fill with blood. The clitoral body becomes engorged and the glans pulls back from the prepuce, making it less visible. Erection is a misnomer for sexual arousal in women. The clitoris does not go erect, as it cannot climb up.

Venous occlusion, the blocking of blood outflow, differs in women. The clitoral cavernosa have no venous plexus pressing against the tunica albuginea. There is no Buck's fascia either for the deep dorsal vein to be pressed against. The only mechanism which blocks outflow to some extent is the front fibers of the bulbospongiosus pressing against the dorsal vein. The clitoris becomes engorged with blood, but it cannot go rigid. The ischio and bulbo cavernosus muscles pressing against the penile base does not happen as well. The clitoris does not harden during an erection. Women will need continued stimulation to keep arousal intact, unlike men who can maintain an erection for sometime even with no direct stimulation.

3.7.2.1 The vaginal response

The vagina receives its flow from an artery largely different from those serving the clitoral bodies, the internal iliac artery. Even with no sexual arousal, more blood flows to the vagina and it gets lubricated by moisture seeping out of blood vessels, on physically pressing inside the vagina. The oscillations in blood flow, the VPA (Vaginal Pulse Amplitude), seemingly depend on sexual arousal, but this is disputed. Stimulating the anterior wall of the vagina or the cervix reduces pain sensitivity. Since injuries which cut the spinal cord leave part of this analgesia intact, it is presumed the autonomic vagus nerve (the only nerve in the pelvis which bypasses the spinal cord) plays a part.

The vaginal responses specific to sexual arousal are the lengthening of the vagina, expansion of the inner canal, and even more lubrication beyond that required to smoothen intromission.

3.8 Orgasm

Stimulating genitals after arousal leads to orgasm. Practically, it is the release of muscular tension (myotonia) and blood build up (vascocongestion) which characterizes arousal. That the muscular contractions of orgasm are a pleasure is widely accepted. Why so is unknown. Muscular spasms are not by themselves always pleasurable. The one associated with orgasm is.

3.8.1 The muscular system

Orgasm is driven by the pulsatile contraction of the bulbospongiosus, ischiocavernosus and pubococcygeus muscles. The first two of these are internal muscles, while the third is the outside muscle of the perineum. The contractions remove the venous occulusion, the blocking of the nerves, quickly draining erectile tissue. Smooth muscles of the arterial walls in the penile region contract, causing arteries to go back to normal.

3.8.2 Ejaculation

Ejaculation is the forcible spewing of semen out via the urethra. This is confined to males. Women can have fluids flowing during arousal from various glands, but they do not generate semen. They do not ejaculate in a forced spurt through the urethra.

Semen has about 4% sperm. The rest is various liquids from the prostate and other glands. Seminal emission, the movement of semen slowly up the vas deferens and urethra, depends on triggers from the sympathetic nerves off the lumbar spinal cord. These nerves trigger smooth muscles lining the vas deferens and urethra to respond, moving semen up. At some point, men sometimes realize ejaculation is inevitable. Seminal emission plays a role in triggering ejaculation, but the mechanism is not understood.

Ejaculation depends on the parasympathetic nerves in the sacral region of the spinal cord. These nerves control the bulbospongiosus and ischiocavernosus muscles. They contract to force semen out the urethra. This has been directly observed in male rats, but is thought likely to apply to men as well.

3.8.3 The refractory period

Men have a longer refractory period, where they cannot be aroused again after an orgasm. The hormonal changes which cause this are not well understood. Both OT and PRL are thought to play a part, with PRL believed to be a satiety hormone leading to the refractory period.

Women have no refractory period. This may be because the arousal is different, being softer with veins not fully blocked, and because they do not emit semen or ejaculate. One study did find more PRL rise in women after orgasm, than in men, casting doubt on its status as the satiety hormone.

3.8.4 Function

The function of the male orgasm is obvious. It is what makes a man reproduce. The facts of the female orgasm point to itt being a byproduct. We will later see Lloyd's take, derived from the near-consensus in EP (Symons, Buss). Bancroft agrees.[30]. Based on his own survey of women in heterosexual relationships, he found just

29.6% of women thought it important to orgasm to be sexually happy. Feeling emotionally close to the partner came in first at 83.5%, with the partner being sexually satisfied a close second, 78.9%. The early faith of feminism, that men and women differ in the sex act because society teaches them to, is in retreat.

The clitoris is present in all mammals, and is evolutionarily even more ancient. The group closest to the primates, lagomorpha (rodents and rabbits), do not have females who orgasm. The IC and BS muscles atrophy in the females, and without them, the muscular contractions of orgasm cannot be. Female primates potentially can orgasm, since they do have the genital apparatus. However, in non-apes, the pubococcygeal muscles control the tail, and are unlikely to spasm at the climax. This makes it hard to spot the coming. We will see in the next chapter how poorly humans have done recognizing orgasm in women. Without the pubococcygeal contractions, it is unclear how we would do better detecting it in wild primates.

3.8.5 Vasectomy

Vasectomy ties the tubes through which sperm comes out. It requires surgery. Men still ejaculate, but semen is reduced by about 5%, the amount of sperm in it. The vas deferens, the semen tube, has thick walls, thicker than the inside of the tube. Largely, vasectomy is reversible, but fertility is often reduced after reversing the operation. This is because chemicals which break down sperm build up in the testes, as the sperm cannot get out and is broken up inside the testes itself.

3.9 Development of desire

How sexual desire develops is core to many theories on gender identity and sex preferences. It is also central to studying current problems such as teen pregnancies.

3.9.1 Defining Desire

The way Bancroft uses the term, desire is part of arousal. Arousal implies desiring sex, but the converse is not always true. Desire is the incentive motivation side of arousal. This leaves open the question of the very first arousal, which cannot be motivated by the learned incentive of the pleasure. Bancroft does not address it, but in the hormonal milieu associated with arousal, only T seems capable of driving it, since dopamine, beta-endorphin, and the peptides, OT and AVP, are all triggered by reward mechanisms related to learned pleasures. They are the hormones of addiction.

3.9.1.1 Sexual fantasy

Studies show, contrary to the Freudian view, the sexually active fantasize more. Men fantasize more than women during non-sexual activity and masturbation, but not during intercourse. Men more than women imagine doing something to their partner; women more than men imagine having something done to them. Males report more explicit and visual images, females more emotional and romantic ones. Fantasies of forced sex occur in both sexes stereotypically, but more in women. Men relate desire and pleasure, while the other sex separates the two. Males are more likely to focus on the woman's pleasure, while females tend to focus on their own. The studies do not attempt to separate biological and cultural parts to fantasies. Fantasies do not seem to be related to real behavior either.

3.9.1.2 Responding to erotica

As we saw earlier, men respond more to erotica, especially the visual kind. Bancroft believes erotica may change to appeal more to women, over time, as they become less inhibited in enjoying it. He thinks the response difference has narrowed in recent years, probably due to this.

Studies on erotica suffer from several problems. The first is photos and films do not capture the real world. They are two dimensional. The pictures are often posed and touched up. At a conscious level, people know their attraction to a photo or a porn star cannot be consummated, especially in a lab setup. Subjects cannot reasonably expect to fulfil their urge, with the depicted person. Using how people are attracted to erotica as a proxy for real-life mating preferences is fraught with issues.

3.9.1.3 The Internet

Searches on the web are predominantly sex related. In 2001, 33 of the top 40 websites visited by males aged 18-24 years, were seemingly adult websites. Men use the sexual Internet more to access explicit material, while women use it more to chat, or for cybersex. The gender ratio of those going to porn sites and chat rooms is heavily skewed, 6:1, toward men. In a large scale 2001 survey, the biannual General Social Survey associated with the University of Chicago, 24% of men and 4.2% of women answered they had visited a sex-related website in the last month. In an Australian survey, 16.5% of men and 2.4% of women reported intentionally visiting such a site.

3.9.1.4 Individual differences

Studies have not seen personality characteristics, as measured with psychological metrics, correlating with individual sex behavior. Some association has been found in clinical populations, that is in those with personality disorders. But no strong ones in the general population.

3.9.1.5 Sex differences

Orgasm varies in women, with many requiring to be specifically stimulated beyond vaginal intercourse (Bancroft, p. 231). More women than men never experience orgasm, even looking only at Western populations. Women are more likely to experience companionate love and men passionate love. Sexual interest or desire, a difficult concept, appears, on average, to be stronger in men than women, with the two sexes differing in what they desire. Women tend to be more easily inhibited in their arousal and response, per Bancroft's view. Blumstein and Schwartz, from a study of couples, concluded that for women, whether lesbian or otherwise, emotional attraction preceded erotic attraction, while for men it was the opposite. Women emphasize feeling emotionally involved and close.

The last part of the section on sex differences, on page 232 of Bancroft, hints where he thinks women are at: " . . . we might expect to find that most women fit the basic pattern, whereas a minority fit the super-added pattern." The remarks are on a survey of 853 women in heterosexual relationships. In full, the question was: 'How often did you think about sex with interest or desire? This includes times of just being interested, daydreaming or fantasizing, as well as times when you wanted to have sex.' The time period was the previous month.

Table 3.3 Frequency of thinking about sex in women

	20-35	35-60	51-65	Total
Not at all	3.2	7.0	13.5	7.2
Once or twice	19.1	18.6	31.9	21.8
Once a week	30.4	31.5	31.2	31.0
Several times a week	27.8	29.9	16.0	26.0
Daily	19.5	13.0	7.3	14.0
Total	35.0	42.0	23.0	100

Bancroft leans toward believing only a minority of women have the super-added pattern in this country. Here a woman who does not desire orgasm the way a man does, is considered psychologically dsyfunctional by men, specialists and laymen alike. With numbers less than 50%, despite strong cultural learning to the contrary, EP cannot consider the super-added pattern species-typical.

3.9.2 Childhood sexuality

Stimulating genitals is pleasurable for boys and girls. Unfortunately the reports on children and sex see non-erotic touching of genitalia also as sexual. One report has boys usually beginning genital play at about 6-7 months of age, and girls at 10-11 months. This makes one wonder what genital play means. Is thoughtless touching of a part of the body sexual? With older boys the issue is more clouded, since urination requires them to handle genitalia, at least the way it is commonly done. What matters is when children start assigning a sexual meaning to their touching. Penile erections can occur in children and in infants, but the pre-pubertal penis is not fully developed, and the hormones, mostly T, are not present before puberty. This applies to girls as well. We will hence look at orgasm and ejaculation as more reliably indicating a sex behavior.

In Bancroft's study, about 12% of women and 13.5% of men reported their first orgasm before puberty. For women, the mean age was 8.5 years and for men 9.6. But this is based on self-reports, and the bias is usually toward pushing the age back.

3.9.3 Developing gender identity

Gender identity is identifying as male, female, or transsexual. Evolutionarily, only male and female are species-typical. The reproductive sieve of natural selection sees to that.

The only gender identity we need to worry about is the one related to sex. The social one, the gender roles a person likes or is drawn to, is irrelevant to us. A man who likes to knit is different from most other men. This does not mean he is different sexually. While sex biology may decide some of what we are disposed to be like, say loving to hunt, those who do not conform need not be considered special. There is no particular need to categorize people into social genders in a society where every individual does what he or she feels disposed to. Hence we will skip the studies on how many men and women fit into expected gender roles and what they feel about it. The data are anyway inconsistent across studies. This does mean an ideal world should have no gender-specific roles except the very few related directly to biology.

3.10 Influence of and on society

Our societies have been built on guaranteeing one mate to practically all adults. Sex is at the core of social norms, and social norms affect almost all sex behavior.

3.10.1 Sex surveys

Sex surveys, except Kinsey's, have been often agenda-driven. The agendas have ranged from concerns about masturbation, declining birth rate, improving marital sex, eugenics, harmful effects of premarital sex, teen pregnancies, and STDs. Earliest surveys did not address women's sexuality, assuming they had less drive. Kinsey's was the first truly objective one.

After Kinsey, surveys have become popular. But they have tended to sell the idea people are more have covered mostly students, and used them as research subjects as well, since these surveys generally get little funding. Planned large studies have often been pared back after their funding got cut. On the techniques front, employing national survey organizations to generate a sample is costly. This has led to participation bias, where those responding are ones motivated by agendas. Interviews are a problem because of the stigma associated with various sexual behavior, and people being generally reluctant to discuss sex. Phone surveys get responses only from idle people.

3.10.2 Masturbation

The proportion of women masturbating has increased in recent studies. The rates, the reporting, or both have gone up. Numbers vary across the West, from the US to Germany. They also vary across studies. For women, the principal method is stimulating the clitoris, at times inserting something into the vagina. Vibrators are now commonly used. The sex difference in masturbation still persists, though it has lessened. Bancroft thinks the women who show only the basic pattern will have little need to masturbate. But his theory does not directly lead to this. Those exhibiting the basic pattern can be reasonably expected to still have the potential to stimulate the clitoris, and masturbation should follow.

3.10.3 Premarital sex

The human female is the only primate with breasts fully developing before first pregnancy. This may mean she becomes sexually attractive before becoming fertile. A young female chimpanzee mates an average of 3600 times before first conceiving, as per Sarah Hrdy. Different from humans. The age of first intercourse has continuously gone down for both men and women. The monthly rate seems to have modestly risen in teenagers, with about 9.4 for men and 3.5 for women in 1981 Germany. Different numbers for the sexes indicate the numbers are largely fantasy, more likely on the male end. The female number of 3.5 per month seems the more likely one.

Many sex surveys suffer from the problem of mismatched numbers across sexes. Rate of sex, number of partners, rate of premarital sex, and adultery should roughly match between men and women. Typically the numbers tend to be higher for men, following the stereotype of the male who exaggerates. It also makes one wonder what other reported data gets skewed by similar psychological effects, this being the one issue on which people tend to hide the truth.

3.10.4 Marriage and living together

While citing the EP studies on women's mate preferences, Bancroft concludes: "Obviously, in today's society in which we are all bombarded with visual images, women cannot be indifferent to how men look, but it is reasonable to conclude that such factors are of secondary importance in their selection of a sexual partner, at least of a long-term sexual partner." He bases this on studies such as Dion's which showed two partner characteristics many women found sexually arousing were 'seeing a partner doing something that shows his talent' and 'someone doing something that shows he is intelligent'.

For men, an attractive woman is one who is clearly nonmale, and vice versa. This attraction would have existed from the beginning of sexual reproduction with two sexes. We are attracted to static features, to physical behavioral traits such as walking or laughing, and psychological traits.

Romantic love as the basis for marriage is relatively new. It seems more important for women when it comes to sex. In a French national survey, two-thirds of women said they were very much in love with their first partner, but only one-third of men said so. Brain studies show passionate love activates the incentive motivation system and partly deactivates critical appraisal. Though Bancroft adds a bang at the end of the sentence, it is unclear why this is a surprise.

One study of American couples in 1983 supported the traditional pattern on mating. Only 12% of wives said they were more likely to initiate love-making and only 16% of the men said their wives were more likely to do so. Around 51% of husbands usually initiated sex. Many men often felt uncomfortable when the partner initiated, and many felt guilty for failing in their duty to take the first step. Women found it more difficult than men to cope with refusal. It is unclear how much this is taught behavior. Where dating is the door to mating, men are taught to expect and accept refusals. Women may have been taught men are easy, rightly or wrongly.

3.10.4.1 The importance of orgasm

The popular culture seems to overrate how important orgasm is, specifically tied to sex. In a British survey in 1990, responding to the statement 'sex without orgasm, or climax, cannot be really satisfying for a woman', 50% of women disagreed and 29% agreed, while 35% of men disagreed and 37% agreed. The results from a 2003 Kinsey Institute survey of 987 women in heterosexual relationships are shown below:

Table 3.4 How important to your sexual happiness is it . . . ?

	Not at all	Somewhat	Moderate	Very	Extremely
to orgasm	10.6	32.4	27.4	24.7	4.9
to feel emotionally close to your partner	2.4	6.5	7.5	46.7	36.8
that your partner be sexually satisfied	1.7	6.9	12.4	52.1	26.8
you are comfortable talking to your partner about sex acts	4.1	10.1	24.3	37.5	24.0

Women relate frequency of sex to the health of the partnership relations, but Bancroft wonders whether it is sex per se or the fact that their partner wants it (that is the woman is 'desired') that is important. He concludes feeling aroused appears to be only marginally important to women's sexual well-being.

3.10.4.2 Menstruation

In general, menstrual blood turned off men, with 67% of the French finding it unpleasant, and about the same proportion of Americans inhibited by it to varying degrees. Women's interest seemingly peaked about a week before ovulation.

3.10.5 Class and culture

In US surveys such as Kinsey's and Laumann's, education level, along with income, defines class. Kinsey's was limited to white males and females because data collected on African-Americans were not enough, by his standards, to publish. Many other surveys control for race and ethnicity before determining class. Some do not, complicating comparisons. European studies, particularly British, sometimes use social class, a vaguer concept which cannot be translated and compared across nations. Laumann saw more conservative attitudes in the lower educational groups, whereas masturbation was more likely and more frequent in the better educated. The class differences reported by Kinsey in petting, age of first intercourse and techniques, have narrowed considerably in recent years, making the categories less meaningful. Oral sex increased across all classes by the time of Laumann's study, 1994, and even more later. The last probably from the publicity of the Bill Clinton sex scandal.

Cultural influence is less well-studied. Western nations do not vary sufficiently in tradition and cultural learning that studies across them can be considered cross-cultural. Studies on other cultures by Western scientists, particularly ethnologists, are problematic. Many, from Meade to Beach, have been challenged in recent years. Some, such as Jared Diamond, have even been sued. Studies by local sexologists are even less credible, biased by trying to get the numbers to agree with the reports of the West, against what serious sociologists believe. There is an entire book on a survey of sex in China, by Liu D and others, with females reporting numbers similar to the West. However, at the beginning the authors mention they did not explicitly ask whether women had orgasms, since most did not understand the question. One wonders how answers to questions such as female sexual happiness could then be compared to Western surveys. Sexual pleasure from intercourse is a meaningless concept if that pleasure refers to different things in different cultures.

Bancroft has a few surveys on immigrant populations in the US and Canada. Brotto found Asian female college students in Canada reporting more anxiety when anticipating sex, along with less knowledge, experiences, less liberal attitudes, lower rates of desire, arousal, receptivity and pleasure, than Euro-Canadians. Studies in the US found sex to be less important for Chinese and Japanese women than for whites, with African-American women finding it the most important.

We saw Liu's survey was in a population which did not understand what the female orgasm meant, but the numbers on pleasure and the like matched Western studies. The direction Liu steers his survey indicates, in the non-West, the West's mores on female sexuality are seen as the gold standard by men, even if its increasing rejection of marriage is not.

3.11 Ageing

Ageing is a graceful decline of the physique. In this section, we refer to people over the age of forty five, an arbitrary line. Sexual thoughts decrease with age, with women reporting them less frequent across the board. For men, erotic thoughts do not depend on whether they have a sex partner, while women with no partners are twice as likely to report no sexual thoughts as those with partners. With little simultaneous polygyny and virtually no polyandry, women and men should theoretically find partners equally easily. Hence lack of desire seems to lead to not having a partner, and not the other way. Men increasingly had erectile problems as they aged, while women had lubrication difficulties. Lubrication is associated with estrogen, which reduces drastically after menopause. Testosterone also declines with age. But men vary considerably, with about 20% of 70-year-olds having T levels in the upper third of the normal 20-40-year range. There is an increase in SHBG with ageing, reducing active T in men. In women this is less clear with studies showing inconsistent results.

Menopause reduces estrogens in women. The labia majora (outer lips) lose both fat and elasticity. The color change of the labia minora which predicts orgasm also vanishes in postmenopausal women slowly. The vagina becomes tissue-paper thin, light pink, short and narrow. Bancroft concludes women with the basic pattern see their sexuality decline more post menopause, than those with the super-added pattern.

The symptoms of menopause differ across cultures. Japanese women complain commonly about stiff shoulders, probably from stress. This study, by Lock, also found hot flushes less common among Japanese than Western women. This could be cultural or genetic. The long history of wrongly guessing a genetic cause for population differences, from digesting soybeans (the Chinese cooked it differently) to sex anatomy of ethnic groups where women shaped their labia, should make one wary of the genetic explanation.

3.12 LGBT

The percentage of people who identify as exclusively gay is around 2-3% in the Laumann survey. Bisexuality seems more prevalent in men.

Some studies show desire developing earlier in homosexuals of both sexes, at an average age of 9.6 years for boys and 10.1 for girls. Average age of the first same-sex fantasy was 11.2 and 11.9, with first same sex activity at 13.1 and 15.2 years. Another study found people being aware they were homosexual typically at age 10, with the coming out at around age 16. Other studies have shown conflicting results, probably because of responder bias. In heterosexuals, the age of first desire and first attraction are similar, around 11 years in boys. Heterosexual desire seems to depend on there being someone to desire and be attracted to. An earlier age for developing attraction sometimes seems to be correlated to same-sex preference.

3.12.1 Homosexuality and bisexuality

The first major report on homosexual behavior was from Kinsey, who reported 37% of males had some gay experience to the point of orgasm, between puberty and old age. A re-analysis carried out later by Gagnon and Simon showed the gay behavior occurred largely in adolescents. Other surveys show smaller numbers. A 1991 analysis by Rogers and Turner, combining three surveys for a total of 2449 men, showed 5 to 7% of men reporting same-sex sexual contact at some point of their lives. Such contact was more in urban areas, and among those who were unmarried till a late age. In Laumann's survey in 1994, 2% of men and 0.9% of women reported they were homosexual, with 0.8% and 0.5% bisexual. In a longitudinal British survey over 10 years, the percentage of men with same-sex experience climbed from 5.3% to 8.4% and women from 2.8% to 9.7%. This survey also showed homo sex being associated with boarding schools, which is a British institution mostly same-sex. An Australian survey showed 4% of men had sex mostly with other men, while for women the percentage was 7.5%. Bisexual sex was reported by 0.4% of men and 0.5% of women.

On the sex act front, Laumann's survey showed most gays engaged in oral sex, 89.5% active and 89.5% receptive. A somewhat smaller majority went for anal sex (75.7% active and 81.6% receptive). The numbers for this were lower in British (56.9% and 53.5%) and Australian surveys (37.5% and 29.8%). For women, nearly all lesbians reported manually stimulating their partner. Oral sex was also popular, 60 to 70% in various surveys, with receptive being somewhat more than the active side. Penetrating the vagina with fingers was reported by 84% (often) in a British study, with mutual masturbation at 71% and genital-genital contact at 50%.

The gay world is not rosy, likely because of our social norms. Suicide attempts were reported by 28.1% of gay and bisexual males, and 20.5% of lesbian and bisexual females, in a study of junior and senior public high school students in Minnesota. Strikingly, 14.5% of heterosexual females also reported suicide attempts.

Gay marriage has been legal in Denmark since 1989. In a population group (cohort) of around 2 million Danes, 1890 men and 1673 women went for same-sex marriages between 1989 and 2001. The rates were highest when the law was first passed, and have stabilized by now.

3.12.2 Transgender identity

Transgender identity is complicated. While some cultures have a third gender, such as the Hijras of India, this is indeed rare. In some cases, transgender identity is from gender dysphoria, that is discomfort with one's assigned gender, while in others it is from not wanting to be gay or lesbian. Thus a woman who likes women for sex, might decide she is a transgendered male, to avoid being thought homosexual. The transgender include the transsexuals who change biological gender through hormones and surgery, lesbians with masculine attitudes (butch lesbians), gays with feminine attitudes, and heterosexual transvestites (cross dressers).

3.12.2.1 Incidence

Surveys recognize transgender identity by counting those who seek medical help to change gender or for gender dysphoria. Their numbers have gone up steadily in the West, to about 1 out of every 7500 males and 1 of every 31000 females. That is 0.013% in men and a quarter of that in women. The increase is probably from people being more aware of transgenderism, and gender reassignment surgery being more easily available, than from transgender identity becoming more prevalent.

3.12.2.2 Causes

Green undertook a study in 1976 on gender identity discordance in boys. Typically such boys were more interested in cross-dressing, choosing female roles in games, preferring dolls, and relating better to girls. The cross-dressing seemed to start by the age of five or six. He identified a number of causes:

1. Parents did not enfore the norm of masculine behavior in the first year. Roughly half the cases showed this.
2. Parents, particularly the mother, encouraged feminine behavior in the first year. This seemed to cover 10%.
3. About 15% of mothers cross-dressed their boys.
4. Mothers overprotected boys.
5. The mother had excessive physical contact with the boy, in about 15% of the cases.
6. The father was absent or rejected the boy.
7. About a third were beautiful in a feminine cultural sense.
8. Another third lacked boy playmates.

Young girls with boyish interests are more common, and generally fit well into the adult world. The tomboy girl rarely has trouble being an adult female, even with unusual hormonal systems.

Children with a gender identity disorder do not necessarily develop an adult transgender identity. They are more likely to become homosexual, though the preference and transgender identity are not mutually exclusive.

How genes affect transsexualism is unknown, with both concordant and discordant identical female twins known. In the brain, the bed nucleus of the solitary tract was shown to have fewer neurons in six male-to-female transsexuals. This region has fewer neurons in women than in men, but the difference shows up seemingly only in adolescents. The cause and effect direction is unclear here.

Prenatal influences also exist. One male and two females, out of 243 who had been exposed to barbiturate (painkiller) anticonvulsants in the womb, showed transgender behavior. These drugs are known to affect how male and female animals behave, differently, possibly by directly affecting the brain or by how the liver metabolizes steroids. Female transsexuals sometimes report raised T levels, irregular mensus, or polycystic ovarian disease. The raised T level needs to be treated cautiously, since it is possible transgender women ingest T (exogenously administered T) privately, and not report it since it may be illegal.

3.12.2.3 Gender reassignment

Many transgender people surgically change their gender, along with a hormonal regime. Surgically, it is easier to convert male genitalia to female than the other way. For the male to female change, the operation involves orchidectomy (removal of the testes, colloquially, castration) and penectomy (removal of the penis), with the scrotal and penile skin kept. The penile skin and an additional graft is used to make the vaginal tube. The labia are fashioned out of the scrotal skin. Nerve endings cannot be retained.

For the female-to-male change, mastectomy (breast removal), hysterectomy (womb removal) and oophorectomy (removal of the ovaries) are done. The artificial penis and scrotum can be used to urinate, but will not become erect. This means it cannot be used sexually.

For male to female transsexuals, estrogens, and sometimes progesterone, are prescribed. This could lead to the breasts getting somewhat bigger, fat being redistributed more femininely, the skin becoming softer, and sexual interest reducing. The voice does not change. Antiandrogens may also be prescribed, and they slow down hair growth and improve breast growth. Mammoplasty, that is breast implants, might be done to enlarge breasts further.

For the female to male transsexual, the right hormone is T. This increases body and facial hair, causes the clitoris to become somewhat larger, increases muscle bulk and body weight, and deepens the voice. A gel form of T applied to the skin is the most popular.

3.13 Other variations

Sex variations are many, and mostly rare. We will look at the more talked-about, even if not the more frequent, ones.

3.13.1 Asexuality

An asexual is one who is never attracted sexually or reports significantly less dyadic, toward a second person, desire. In a British survey, 0.8% of men and 1.2% of women reported they had never felt sex attraction. Similar results were found from Australia, with a corresponding gender gap. Lifelong asexuals still seem to masturbate for pleasure. Asexuals were more likely to be women, religous, short, less educated, poorer and in worse health.

3.13.2 Fetishes

Fetishism is a graded continuum. In general, it is getting attracted to a stimulus or signal associated sexually with people. Could be to parts of the body, an extension of the body such as clothing, or things nice to the touch, such as wool or leather. Almost exclusively, only men but not women are drawn to such objects. Feminists have tried to correct this perception by defining sex toys such as dildos as fetishes, but that is against the common use of the word.

Getting attracted to parts of the body is not necessarily obsessive. Men, by and large, are attracted to feminine body parts. An attraction is a fetish when it overrides the desire for the person as a whole. Hand and foot fixations are the common body-part ones. A few souls are drawn to lame women or female amputees. Such men often end up with a desire to amputate limbs, apotemnophilia.

Clothing, shoes and boots are the most common fetishes. Some fetishes are linked to babies rather than women, such as being attracted to diapers.

Some people are sexually obsessed with clothes of rubber or leather. Among articles of clothing, underwear such as panties is the most common fixation. Wearing them, looking at them, or fondling them, the associated behavior.

Fetishes result from sexual response being conditioned to particular stimuli. Bancroft believes fewer women have these since they are not aware of their genitalia responding. Also, being unable to establish dyadic relationships may encourage fetishes, because of the lack of whole person stimuli. Some are associated with neurological abnormalities such as temporal lobe epilepsy.

3.13.3 Sadomasochism

Ritualized, consensual, sadomasochism is commonly called BDSM (Bondage, Discipline, Sadism and Masochism). Straight BDSM males tend to be more interested in getting humiliated, while BDSM women, whether hetero or lesbian, tend to prefer bondage, spanking or master-slave scenarios, at least as per a 1994 study. Those reporting BDSM tendencies are more likely to be males, with 18-20 years the age when they first became aware of the tendency. Masochists experience sexual arousal when under pain. A common form of this is the love bite, widespread among mammals. Kinsey reported, in 1953, that 55% of women and 50% of men interviewed had responsed erotically to such bites during lovemaking.

3.13.4 Pedophilia

Pedophilia is diagnosed as a disorder by the American Psychiatry Association. In its manual of disorders, the DSM, version 4, pedophilia is defined as recurring, intense, sexually arousing fantasies, urges, or behavior involving being sexually active with a prebuscent child or children, generally aged 13 or younger. Rarely, pedophilia results from pathological conditions, but its roots are social and cultural. Adult men are attracted to teen girls. While not socially acceptable, this is normal. As we go down the age range of teens, men feel less attracted to girls. The cut-off age corresponds to the developmental change of puberty.

Most pedophiles are men, and hence this section focuses on them. An old study, a 1972 one, looked at penile volume change in 40 non-offending heterosexual men, with mean age of 24.5 years, looking at images of males and females of ages from 6 to adulthood. They found men reacting most to post-pubertal and adult women, but more to pre-pubertal girls than to the males. Images of pre-pubertal children showing only the pubic region, and to some extent the buttocks, elicited erections. The rest of the body, presumably enlarged breasts and adult body proportions, seems to make pubescent girls more attractive than younger ones. Another study showed the same category of men enticed less by pubescent girls than by adult women (around 70%). Bancroft hypothesizes that boys start attracted to girls the same age, and as they develop, the attraction also changes the same way to older girls. This theory implies segregating teen boys and girls, common in the past and in many cultures even today, would change the nature of sexual attraction. This has not been shown, and from sociological arguments, seems unlikely. The theory of EP, and the data they have collected, indicate men prefer younger women. Women trying to appear younger seems to bear the theory out. One way or the other, men are more attracted to girls past puberty. They are attracted some extent to pre-pubescent girls, but the preference is weaker. It is unclear what part of it is learned. Evolutionary psychology claims men should have adaptations against desiring pre-pubescent girls, to avoid waste of mating and reproductive effort.

3.13.5 Rare variants

Autoerotic asphyxia (hypoxyphilia) is arousing oneself sexually by hanging or strangling, or suffocating inside a bag inhaling fumes. Men who have been hanged are known to have been sometimes aroused to the point of ejaculating. Though most who practice erotic strangling are males, some women also do it. The mechanism seems to be related to increasing arterial Carbon Di Oxide. This increases cerebral blood flow, with just 7% of the gas doubling it. The choking game is a variation on this theme.

3.14 Sexual problems and treatment

Many clinical conditions such as diabetes, brain tumors, injuries to the spinal cord, affective disorders such as clinical depression, and psychotic illnesses such as schizophrenia can cause sexual problems. The treatments can also interfere with sex. The following subsections look only at problems which are primarily sexual in nature.

3.14.1 Female problems

Classifying sexual problems in females is harder than in males. The first issue is what counts as a disorder. Is lack of interest a disorder? The DSM does have a diagnostic category, HSDD (Hypoactive Sexual Desire Disorder). Low desire, in itself, is not a dysfunction. It becomes so only when accompanied by distress as measured with a personal distress scale, a questionnaire. Leiblum and others, in 2006, sampled 414 pre-menopausal women and 252 post-menopausal women. Low desire was reported by 24% of pre-menopausal and 29% of post-menopausal women. When distress was taken into account, the numbers fell to 14% and 9%. Even with the culture teaching women sexual desire is the natural way, large proportions do not think lacking it a problem. Something which holds even more for post-menopausal women. Other studies show, for most women, general health, especially mental health, and the subjective quality of sexual interactions, determined distress more than anything else.[31]

Of women who report a sexual problem as defined by the surveyor, only some think it a problem. Only 69% of those who reported dyspareunia called it a problem. The numbers for decreased sexual interest fell to 43%. Numbers are from a Swedish survey of 1335 women in 1996. There is a recurring discord between what researchers consider a sexual problem and what the woman herself thinks. To quote Bancroft from p. 316: “Many women are content not to experience orgasm, at least not every time. Others are put under pressure from their partners to ‘come’ as if it were a test of male’s potency.”

3.14.1.1 Dyspareunia

Dyspareunia is pain during sex. This could be from a dry vagina, an infected vagina or vulva, scarring from episiotomy, or pelvic problems such as endometriosis.

Lack of estrogen leads to a dry vagina. It is more common in postmenopausal women, though occuring in others as well. A painful and tender vulva indicates the condition vulvo-vestibulitis, and if a burning pain persists even with no touch or pressure, the condition is called vulvodynia. In some cases, the pelvic floor muscles are tense, and do not allow the vagina to open up. This is vaginismus. It is the most easily treated of all conditions, and involves using dilators, of steadily increasing sizes, inserted into the vagina gently. This, over a period of days, relaxes the muscles. The cure rate is high for this disorder. There has been a proposal to classify dyspareunia as a pain disorder, similar to headaches or shoulder pain. Vulvo-vestibulitis is probably from increased pain sensitivity in general, or a neural problem in the vagus nerve which mediates the painkilling effect which follows inserting the penis. Genetic mechanisms which prevent microorganisms in the vagina such as the yeast, *candida albicans*, from infecting the tissues, are deficient in some women with vulvo-vestibulitis.

I will skip discussing how to treat the various conditions, this not being a medical text.

3.14.2 Male problems

Male problems can also be either physical or psychogenic.

3.14.2.1 Premature ejaculation

Younger men ejaculate faster, and with more experience, they begin to control ejaculation better. Masters and Johnson defined PE (Premature Ejaculation) as a man coming before sufficiently stimulating the woman. They advocated a squeeze technique, pinching the penis to hold off ejaculation, to lengthen coitus time. While ejaculation before intromission is a true reproductive problem, this is rare. In surveys, the most commonly cited sexual problem by men is PE (over 20% in at least three surveys). Men with liberal attitudes are more likely to report it, indicating they define PE to be coming before the woman does.

3.14.2.2 Erectile dysfunction

Other surveys show, among those who go to clinics for sexual problems, erectile dysfunction dominates. Almost half of men have this as the main problem, with PE being around 13%. Erectile dysfunction could physical or psychological. The baseline test is whether the numerous automatic erections normal men have at night, during REM sleep, are intact. This is not definitive, since the changed hormonal conditions of clinical depression can affect NPT as well. There are many arteries, veins, muscles, tissue, and hormones which together produce penile erection. A problem with any could lead to ED. In women, since the clitoris mostly cannot be seen, and is not rigid or hydraulically lifted when erect, ED is generally not reported as a problem.

4 Mating

The biology and psychology of sex should lead to illuminating the sex act, and how it is to be satisfied. We will look first at how and when women climax, that being the confusing issue on the mating act.

4.1 The mechanics

M&J attempted to explain the mechanics of how women get to orgasm, both during masturbation and intercourse. Prudently for the early 60s, they called masturbation, *automanipulation*, and intercourse, *coitus*, words necessary to understand my quotes from the book.

Uncontroversially, they pointed out the rubbing of the clitoral hood skin against the bulb is what excites women and takes them all the way. This follows from the hood being very touch sensitive, and the bulb sensitive to pressure and rubbing. Women masturbate by rubbing the clitoral skin against the bulb mostly with their hands, or a vibrator. The inner lips are also more sensitive than normal skin, but still not as much as the hood, and they cannot stimulate the clitoris directly.

For intercourse, M&J described the mechanics of stimulation in difficult English:

> Clitoral stimulation during coitus in the female supine position develops indirectly from penile-shaft distention of the minor labia at the vaginal vestibule. A mechanical traction develops on both sides of the clitoral hood of the minor labia subsequent to penile distention of the vaginal outlet. With active penile thrusting, the clitoral body is pulled downward toward the pudendum by traction exerted on the wings of the clitoral hood . . .
>
> When the penile shaft is in the withdrawal phase of active coital stroking, traction on the clitoral hood is somewhat relieved and the body and glans return to normal pudendal-overhang positioning. However, the rhythmic movement of the clitoral body in conjunction with active penile stroking produces significant indirect or secondary clitoral stimulation.

Despite the wording, this explanation is speculative, not definitive.

Feminists would see this as excusing the age-old way of sex, since this mechanism would get women their pleasure with the straight missionary position. Feminists would also rephrase the description in clearer words, to attack it all the better. Hite:

> In other words, the clitoris is surrounded by skin known as the "clitoral hood" that is connected, in turn, to the labia minora. Supposedly, during intercourse the thrusting penis (notice the assumption of female passivity) exerts rhythmic mechanical traction on the swollen labia minora, and so provides stimulation for the clitoris via movements of the clitoral hood. Sherfey has termed this the "preputial-glandar mechanism" wherein "the thrusting movement of the penis in the vagina pulls on the labia minora, which, via their extension around the clitoris (the clitoral hood or prepuce) is then pulled back and forth over the erect clitoris". That is, the final stimulation is provided to the clitoris by friction against its own hood.

Hite goes on to point out:

> . . . there can only be traction between the penis and vagina when the woman is already at a certain stage of arousal, because only then do the labia swell up enough to cause traction [. . . the plateau phase]. In other words, the penis can only pull the labia back and forth with it if the woman is at the last stage of arousal before orgasm so that there is sufficient engorgement of the area to cause a tight fit between penis and vaginal opening.

In the same section, she reasserts thrusting alone will not rhythmically move the hood over the clitoris. And quotes Alex Shulman and Dr. Stanford Copley to strengthen the point. Copley would compare the M&J model to a visible one: men masturbating by rubbing the scrotal skin (balls), pulling it back and forth, and so causing the skin of the penis to move, or quiver, and this way achieving "stimulation". That does not work. Hite again, with a basic question at the end, unanswered to this day: "Does thrusting do this effectively? For most women, without some special effort, or some special set of circumstances, it does not. Perhaps, finally, it is important to point out that, if this mechanism works so well, why hasn't it been working all along, for centuries?"

Anne Koedt, in her classical article *The myth of the vaginal or-*

gasm, published in 1970 and available free online, would make this point before Hite. Feminists would call for a new way of sex arguing the missionary position and the M&J model of female orgasm resulting from it were seriously flawed. They would point to the statistics which consistently showed many women did not orgasm during plain foreplay-less intercourse with women passive. They would question why female orgasm has been mentioned so rarely in the past in mainstream art and literature. Why coital frigidity, that is women not climaxing during sex, became such an issue once the pleasure became widely known and accepted in the West.

Other mechanisms have been postulated over the years for a vaginal climax. Rachel Pauls and others in *A Prospective Study Examining the Anatomic Distribution of Nerve Density in the Human Vagina* published in the *Journal of Sexual Medicine*, blandly states in the introduction: “Women possess sufficient vaginal innervation such that tactile stimulation of the vagina can lead to orgasm.” But the nerves they describe are not somatic nerves, the kind that conveys the sense of touch and pain from the skin, but vegetative (vagus or visceral) nerves, the kind that goes to internal organs and produces sensations which we are not able to localize (that is figure out exactly where they come from). The brain has a map of the skin surface, called the somatic map, but not of internal organs.

Contrast with Sherfey: “It will be seen that these data lend support to the thesis that the vaginal mucous membrane alone is relatively unimportant as an erotogenic zone.” The data, an entire chapter on how insensitive the vagina is, follow. She points out everything from incorrectly placed tampons touching the lower third of the vagina (the part near the opening) being irritating and not erotic, and the penile glans probably not touching the lower third during thrusting.

> In most females the walls of the vagina are devoid of end organs of touch and are quite insensitive when they are gently stroked or lightly pressed. For most individuals the insensitivity extends to every part of the vagina. Among the women who were tested in our gynecologic sample, less than 14 per cent were at all conscious that they had been touched . . . The limited histologic studies of vaginal tissues confirm this experimental evidence that end organs of

> touch are in most cases lacking in the walls of the vagina, although some nerves have been found at spots in the vaginal walls of some individuals.
> This insensitivity of the vagina has been recognized by gynecologists who regularly probe and do surface operations in this area without using anesthesia. Under such conditions most patients show little if any awareness of pain..[32]

Helen Singer Kaplan states: " . . . the vagina is sensitive to touch only near its entrance. It is lined with a mucous membrane which is supplied with touch fibers only within its entrance."[33]

Over time the various other theories on vaginal sensitivity, such as stretch-sensing nerve endings (Kaplan tentatively accepted this), have been disproved. Mostly the few nerves which are there, offshoots of the pelvic nerve, are highlighted repeatedly. Hite in p. 485:

> Since it has become general knowledge that the interior walls of the vagina are more or less insensitive physically, some sex researches now talk about "proprioceptive feeling"—the sensations caused by the distention of the vagina by the penis rather than friction on the vaginal wall itself. Only a few women mentioned feelings that might come under this heading . . .

At a fundamental level, Hite's basic rhetorical question is a potent one. A valid vaginal orgasm theory has to explain why it has been rare for most of history.

4.1.1 The history of the drive

There have been attempts to answer Hite, mostly by trying to show females had the urge for easy orgasms from intercourse throughout human history. *History of sexual customs* by Richard Lewinsohn, admittedly published before Hite, is an example where many an ancient woman's fling is shown as a sex hunger. But it overlooks the lack of record of orgasm, the fulfilling of that hunger. Anecdotal, historical and anthropological evidence from the major civilizations of the past indicate Hite's question is valid. While sex manuals exist from many old civilizations, none mention the visible female orgasm—the 0.8 second interval throbbing of the outer vagina, and the pink or red inner lips before that.

4.1.1.1 Ancient China

Van Gulik's *Sexual Life in Ancient China* covers the period from prehistory till the foreign Manchu conquest. We will follow its treatment. The oldest sex manual known, the Chinese *Handbooks of Sex* written 5000 years ago seemingly by Emperor Huang Ti, and the later Taoist ones, prominently mention both foreplay and techniques to avoid ejaculating (closing eyes, concentrating, pressing tongue against roof of mouth, bending the back). The Chinese considered procreation paramount for sex. They thought what the vagina secreted added to a man's inner strength, while losing semen weakened him.[34] This meant a man should ejaculate while mating with his wife since that was needed to make babies, but hold back when mating with his concubines. Gulik interprets the handbooks to be saying it was a man's duty to pleasure his partner, and to stick to a specific timing and frequency of intercourse. Applying mostly to the ruling class, who were polygamous. Female orgasm from plain intercourse clearly was not the norm, since foreplay and holding back in inconvenient ways are stressed. How many followed the dictates is in question. Beyond the ruling class, polygamy would not have been possible, the sex ratio being 1:1.

Van Gulik, on p. 83, quotes from the famous classic of alchemy, the *Ts'an-t'ung-ch'i, Pact of the Triple Equation*, to show the Chinese believed the basic position assumed during the coitus had to be man lying face down and the woman on her back, since they believed men to born lying face down, and women facing up. What we now call the missionary position was the dominant one there, at least around 150 A.D. when the book was compiled. One handbook, reproduced on page 125 of Gulik, mentions 30 positions, of which 16 have the woman on her back, 5 the man thrusting from behind, 6 are either side-by-side or face-to-face sitting or standing, and just 2 have the woman on top, with 1 a mix. Part 3 states: "the man should thrust from above and the woman receive below."[35] Part VI indicates the clitoris (called the Jade Terrace), and the meeting of the inner lips in front (the Jade veins), were correctly identified as sources of pleasure. But the vagina getting wet is all that is said of the pleasure itself. The recommended sex act is complicated, requiring the man to count his thrusts and measure and control their rhythm and depth (in and out fast, then alternate nine shallow thrusts with single deep thrusts, then vary slow and quick for twenty-one breaths). Paying close attention to the mechanics, spectatoring, is known to retard ejaculation,[36] something the author likely intended.

Later texts from the late Ming period had about 20% positions with the women on top ([84], p. 330). Artificial devices such as rings, fitted to the penis, to stroke a woman better, are described in Chapter 9 of the *Hsiu-chen-yen-i*, from the 16th century. Blocking ejaculation was still considered important.

How to know when a woman has peaked? In common with the other sex manuals we will look at, the Chinese ones had specific instructions. Gulik, p. 139, the five signs: a red face, hard nipples, dry throat, moist vagina, and vaginal fluid dropping between the buttocks. The next section has raising the upper part of the body, relaxing of limbs, and vagina flowing plentifully. The last sentence: "By these signs one will know that the woman has reached orgasm." Later, the description of the seventh position (p. 142) adds one more—great joy and delightful pleasure appearing on her face.

In sum, with the act as described, men are required not to orgasm, and women really do not orgasm. Unsurprisingly, we hear (p. 137): "Those who can practise this art are few . . . "

4.1.1.2 Babylon

The Babylonians have left a wealth of data on their lives. Zainab Bahrani, in *The Women of Babylon*, looks at the role of sex. The Babylonians did not consider the genitals shameful ([6], p. 45). The naked female body was associated with sex attraction, but the naked male body was shown only in narrative scenes where the action, say swimming, required a state of undress (p. 55). No male image is shown with an erect penis (p. 65). The standard sex positions are depicted on several plaques, but the list Bahrani has rarely refers to any woman on top position (p. 51). The wet vulva is mentioned often in literature. Nude women were seen as sex objects by men, but the reverse was not true, as per the terracota art and literature. Both Herodotus and Strabo mention all women were required to prostitute themselves once a year in a temple (p. 169), something which tallies with the Old Testament's railings against the hedonism of sin city.

4.1.1.3 Egypt

The Egyptians of the pharaonic times had even less regard for women's pleasure. Whether they were aware of the female orgasm is not clear. Lise Manniche, *Sexual Life in Ancient Egypt*, p. 33: "It cannot be proven beyond doubt whether female orgasm was acknowledged, but a few passages may be interpreted to this effect . . . " If orgasm from intercourse were easy, one has to wonder whether this would be the case. The first passage refers to a "her moment does not come" in a lust context. The second is of a queen crying out at the moment of climax. The second indicates more likely a fake orgasm.

On sex positions, Bullough ([13]) claims the woman on top was the common position. He bases this on the creation myth, where the sky goddess, Geb, mates with the earth god, Nut, to produce Isis, Osiris, Set and others. The mating is shown in the usual sky on top way. Bullough does not provide evidence to show men mated per the creation myth. After all, the same myth says the sky and earth were created by the Sun God, Atem or Ra, by hand. Since Egyptian civilization lasted for thousands of years, easy generalizations are misleading. Papyrus cartoons depict various sex positions ([60], pages 35, 44, 106), with women on top rare. The graffiti showing even Queen Hatshepsut having sex with chief steward, Senenmut, has him taking her from behind.

4.1.1.4 Ancient and medieval India

The three main Indian erotic texts are the *Kamasutra*, *Rati rahasya* and *Ananga Ranga*. The first is from the early Christian era. For orgasm, Sir Richard Burton's translation, Part II, Chapter 8: "The signs of the enjoyment and satisfaction of the woman are as follows: her body relaxes, she closes her eyes, she puts aside all bashfulness, and shows increased willingness to unite the two organs as closely together as possible." Women on top is covered in a separate chapter, the same one as the previous quote. It is recommended when the man feels tired.

Kokkoka's 10th century *Rati rahasya* has more on sex positions and a different take on orgasm (Chapter III, [53], p. 112): " . . . at the climax they experience a discharge like that of the man, which renders them practically senseless with pleasure. One moment the woman screams, moans, throws herself about and is distressed—the next she lies motionless and closes her eyes." Later, in page 142, the woman is said to go limp, close her eyes and swoon. Foreplay is more heavily stressed than in the Kamasutra, with the clitoris explicitly noted (p. 134).

Alex Comfort's translation of Kokkoka also contains synopses of the lesser-known manuals, *The Panchasayaka*, *Smaradipika*, *Dinalapanika Sukasaptati* and the *Ratimanjari* in full. By and large, these books stick to the Kamasutra, with more postures (bandhas) and more advice on behavior.

The most recent and most popular of the medieval series, *Ananga Ranga* (16th century): "As soon as she commences to enjoy pleasure, the eyes are half closed and watery; the body waxes cold; the breath after being hard and jerky, is expired in sobs or sighs; the lower limbs are limply stretched out after a period of rigidity; a rising and outflow of love and affection appear, with kisses and sportive gestures; and, finally, she seems as if about to swoon." It does mention that the desires of a woman are colder and slower to rouse than those of men. Chapter 9: "Purushayitabandha is the reverse of what men usually practise. In this case the man lies upon his back, draws his wife upon him and enjoys her." The missionary position was the usual. In Chapter IV Kalyana Malla lets slip the real state of affairs: "The custom of society and the shame of the sex may compel her to conceal them and even to boast that they [the desires] do not exist . . . " It was fashionable among elite women to say they had no orgasm drive. Female orgasm, and the drive coupling it to men, had gone underground in India by the early 16th century. The thirty two positions of the Ananga Ranga (11 missionary, 3 side, 10 sitting, 3 standing, 2 with woman on her stomach, and 3 with her on top), just like those of M&J, are difficult to remember or practice. Some are tied to the hatha yoga's postures, hard enough without mating added to the mix. Burton gets over the problem by asserting Hindu anatomy differs, with pliant limbs and the yoni (vulva, primarily the vagina) placed higher (Footnotes 1 and 2, Chapter 9). The first was based on the Hindu tradition of sitting cross-legged, learned as children. The source of the second statement is unclear. The positions are as hard for Indians as for Europeans.

The Tantric tradition of the Hindu Sakta sects and the Buddhist

Mahayanists were either influenced by or influenced the Chinese take on sex. They required men to hold back to conserve semen. Largely the mating act accorded with the Chinese version covered earlier (Appendix 1 of [84], p. 63 and 64 in [53]).

Of the many criticisms leveled against the Indian manuals on the act of life, at least two are objective. They lack pictures. They describe the female orgasm imprecisely and inaccurately. The second has to be because it was rare.

4.1.1.5 Ancient Greece and Rome

Studies of sex in ancient Greece focus heavily on man-boy love, pederasty. To us this part is not material. Pederasty, as practiced in ancient Greece, was likely not from an innate gay inclination. Only sex with boys was allowed, and once they grew up, it was forbidden ([55]). There is debate on whether the masses condemned it ([77], p. 119). The early Greek writings of Homer and Hesiod do not mention it ([77], p. 44). Modern critics often subjectively emphasize symbolic gayness. Skinner, for example, believes that in Bram Stoker's *Dracula*, the Count was homoerotically attracted to Jonathan Harker, the man who discovers what the vampire is ([77], p. 125). Such subjective opinion is difficult to fit into objective arguments. I will avoid the minefield of same-sex attraction in ancient Greece, since we are looking only at how frequent female orgasm was in the past. Skinner's book is a compact text, and the page references below are from it, by default.

The Homeric Greeks believed women were more passion-driven than men and that their capacity for sex, unlike that of men, was bottomless (p. 30). Sherfey's words quoted earlier are echoes from the classical world. But the details were less precise than in her book. Greek medicine believed women were wet and men dry. Hippocrates believed women's flesh was a different texture, spongy and absorbent. Intercourse was thought to irrigate the womb, heat the blood, and make the menses flow. Intercourse was thus considered essential for women's health (p. 32). While Skinner uses the word sexual activity, that is a loose interpretation in a book with a different theme. The data she presents makes it clear intercourse is what Hippocrates thought women needed. Not orgasm. Apart from literature, some idea of sex mores can be had from pottery made in Athens in about 600 to 400 BCE. A few had pictures of intercourse. The common position shown for heterosexual congress was rear-entry, possibly vaginal or otherwise (p. 101).

In the classical age, the time from the victory over Persia at Marathon through the Peloponnesian wars between Athens and Sparta, and ending in Alexander's time, Greek thought on the women's drive seems to have changed drastically. Skinner notes the literary texts rarely mention sexual relations between husband and wife, likely the common variety (p. 147). She quotes two texts, Aristophanes' *Lysistrata* and Xenophon's *On Household Management*. Aristophanes wrote comedic farce; Xenophon not. Xenophon believed sexual pleasure to be the main part of marriage for men, while for the wife it was to do a favor for the man. To quote Skinner: " . . . is he also imputing to her an absence of sexual desire? I confess I find this incidental remark rather troubling." Objective scholarship in the history of sex is hampered by such biases, especially when the subject is vast and the data have to be filtered first based on a gut feel. One feels Greek thought did not change drastically from Homeric to classical times. We just have stronger evidence for what the general public thought, for the latter era.

The Hellenistic period is from the time of Alexander, when a Greek empire extended over Western Asia and stayed on in Egypt under the Ptolemaic Pharaohs, till the eclipse of Greece. Epigrams from the time give us some insight into forms of intercourse. These are brief poems in elegiac couplets. Structured as two lines with the first in hexameter, containing twelve syllables of a specific long and short pattern, and the second in pentameter of ten syllables. Some contain references to the exotic *keles*, or "racehorse" position in which the woman rode the man lying beneath her (p. 168). On the theory side, Plato considered the physical drive of a woman to be a craving to be pregnant, a response to her own internal void, and the sexual act a means to relieve that condition (p. 152). Orgasmic pleasure seems to be out of the picture. Aristotle considered the uterus to be analogous to the male penis and testicles. This is probably what led the Greeks to consider the womb, the *hystera*, to be the seat of women's pleasure ([55], p. 50). Galen, a great physician, went further. He had the uterus be the analog of the scrotum, the vagina that of the penis turned inside out, and the cervix the inside of the penis (p. 153).

Lewinsohn thinks Valeria Messalina, empress of Rome and wife of Claudius, spent nights in a brothel to learn the pleasure of lovemaking ([55], p. 80). This may be gossip and slander, since the empress had many enemies. Be that as it may, the popular idea does seem to have been women had to learn the pleasure. Ovid, from Rome around the time of Christ, in his classic *Ars Amatoria*, book 2, toward the end describes lovemaking:

> to hear her imploring me to slacken my speed so as to prolong her bliss . . .
> But these accomplishments are not vouchsafed by nature to young girls.
> They are reserved for women who have passed the age of thirty-five. . . .
> Learn, by skilful dallying, to reach the goal by gentle, pleasant stages.

At the end of book three, he advices women how to fake the pleasure: "Let your movements and your eyes combine to deceive us, and, gasping, panting, complete the illusion." The ancients too believed that moving, gasping and panting made up an orgasm.

Skinner has more in [77]. In page 195, she mentions the penetration model as the main one. From a feminist viewpoint, this is a dominance-submission relationship. Anatomically it mostly rules out the woman on top position. To be a real man, a *vir*, was to take the insertive position in sexual congress (p. 212). Lucretius' *On the Nature of Things* has women too deriving enjoyment from intercourse, but as we saw above, the details do not agree with the real orgasm. Seneca, a philosopher, mentions the clitoris in describing tribades, women who pleasure themselves by rubbing their vulva against other women. A tribade, as per the philosopher, is one endowed with a clitoris large enough to serve as a penis. She can penetrate not only boys and women, but also men.

4.1.1.6 Later Europe

After Rome comes Christian Europe where all sex pleasure, both for men and women, was considered suspect. The system was designed to suppress it, with mainstream theology considering us born in sin, from the sinful sex act. In a milieu where the mainstream religion classified sex as sin, looking at whether intercourse normally led to female orgasm is misleading. The religion taught it should not ([13], p. 678). The royalty was exempt and the women's drive did get attention there, but again the sham one gets mentioned more. The sex manual, *Aristotle's Masterpiece*, published around 1680 and banned in Britain until 1960, fails to describe the real one. The book is a serious tract, not titillating pornography. It correctly describes the clitoris as similar to the penis, with the glans noted as the seat of pleasure. Unfortunately, the clitoris does not show any changes at the exact orgasm point. Internally it stays erect and from the outside nothing can be seen. What can be seen, the throbbing and the red lips, are not mentioned in the manual. The sex act is vaguely described, and the variation in the clitoris is interpreted ([75], Chapter 1, section 2): "... according to the greatness or smallness of this part, they are more or less fond of men's embraces; so that it may properly be styled the seat of lust." The woman is instructed to hold the man's penis in her hand and guide it. The act is described in verse: "My rudder with thy bold hand, like a try'd and skilful pilot, thou shalt steer, and guide." Women are also described as having testicles and ejaculating by expelling seed. The last is contradicted in Chapter IX, maybe added later.

4.1.1.7 Arabia

The Arabian sex manual of the 16th century, *The Perfumed Garden* by Cheikh Nefzaoui, again translated by Burton, mentions women's pleasure is in the sperm getting deposited in the uterus. It assumes the uterus actually grips a penis which penetrates deep into the vagina, and sucks when it ejaculates. The manual has the usual sections on potions and mixtures to make one more virile, or to improve sex. The vulva is described mainly referring to the vagina, with small differences from women to women used to classify them into many groups.

4.1.1.8 The common thread

Most studies on sex in the ancient world focus on the private life of the uppermost strata, because it is better recorded and more interesting. There for female pleasure, foreplay, various sex positions, and holding back on the man's part, are recommended. All of which point against plain intercourse getting women their pleasure.

If the female orgasm from intercourse were easy, one has to ask why it has been such a mystery for almost all of history. And why we needed sex manuals with difficult positions, almost from when writing began. Manuals mostly imprecise at that, in their technical details. Faking the orgasm seemingly is as old as the word. And one needs to balance these handful of books against the vast amount of fiction, dealing with love and sex, focusing on the male want and pleasure.

4.1.2 Nerves and muscles of the penis and clitoris

After that aside, relevant to the Hite question, let us go back to anatomy. The general idea is the penis and clitoris are equal. However, they are not similar when it comes to nerves and muscles. The bulb of the penis (near its base) is covered by a muscle, the bulbospongiosus also called the bulbocavernosus. The same muscle covers the vestibular bulb in women. The muscle contributes to erection, the contractions of orgasm, and male ejaculation. The middle fibers are supposed to compress the erectile tissue in the bulb to make it erect. The front fibers compress the deep dorsal vein, trapping blood, and again helping the member get rigid.

The ischiocavernosus muscle helps stabilize the erect penis in men and tense the vagina in women. It definitely does contribute to the rhythmic contraction pattern of the orgasm in both men and women. Unlike most other muscles in the pelvic region, the ischiocavernosus is associated only with sexual arousal and not micturition.

In women, the bulbocavernosus front fibers act the same as in men. It is not clear whether the middle fibers also contribute to erection. The main muscle of erection, the ischiocavernosus (erector clitoridis) is smaller than the corresponding one in the male, after adjusting for body size.

These muscles are controlled by the perineal nerve, a branch of the pundendal. The pudendal rises from the spinal cord in the sacral segment in the pelvic area, in location S2 but extending into S1 and S3. This region is called Onuf's nucleus, and the neurons there are motoneurons. For most animals, males have more of them than females. Men have more of them than women. The neural centers of the muscles of erection and orgasm (along with micturition) are indeed less developed in women. The reasons are the same as to why other muscles are less developed in women.

Exposing a prenatal female to high levels of testosterone increases the number of motoneurons in the nucleus. To quote from [79], p. 927: "The issue of sexual dimorphism in the human brain has been quite controversial, but there is no question that there is strong evidence for morphological and functional differences in specific brain nuclei in humans. Homologues to the sexually dimorphic nuclei of rats also appear to be dimorphic in humans. For example, Onuf's nucleus, which is equivalent to the rat SNB [Spinal Nucleus of the Bulbocavernosus], has more motor neurons in men than in women."

4.1.3 The real data

I believe, in accord with the serious researchers, the earlier studies were right on all the facts. The missionary position had been considered inadequate before M&J, by Kinsey. On page 164 he noted: "It is true that the average female responds more slowly than the average male in coitus, but this seems to be due to the ineffectiveness of the usual coital techniques." M&J themselves would later start a sex clinic and advise couples to go for some specific sex positions, mostly with women on top. Others would add to the list of positions over the years, often reinventing practices as old as writing. Practices, being inconvenient, not mainstream. Evolutionary psychologists sum it up best ([16]): "For instance, men complain about premature orgasm while women complain about lack of orgasm. Why? Sex differences in brain mechanisms and differences in anatomic proximity to stimulation . . . ".

4.1.4 Point of departure

Feminists would use the above data to argue men had to try harder to arouse women. They rejected the standard missionary position as inadequate. The data can however point to another way, of equal pleasure to men and women, with less effort for both. I will first look at how much work the current way is for men. Then see how much it adds to a woman's physical pleasure. Finally comparing it to an alternate way hidden by taboo, tradition, and the reaction to tradition. The center lost among the extremes of the pendulum swing, the oppressed woman and the liberated one.

4.1.5 Intercourse and female orgasm

People have mated for all of history trying to get both to climax; those with willing and curious mating partners have tried and written of varied things. Guys cannot easily excite women with their bulb even positioned inconveniently, thrusting from the back, down on the knees doggy style, or almost flat down. A baby comes out through the birth canal stretching but leaving the wall intact, its muscular lining is that tough.

The vaginal wall and a penis unable to move on its own block meaningful excitation for natural, man thrusting straight into a woman, sex. An erect male organ is stiff and straight, not bent or curved. Hence it cannot directly squeeze or massage its equivalent through or along the hood in a masturbatory way for the few who try that out, even if the hood is removed or retracted. For finger play, females can achieve the same results with their own—there is nothing special about a male's fingers. Mouth and tongue are best avoided since genital secretions are unpalatable and unhealthy to swallow, and oral sex spreads infections. A she pushing into a he from positions where she is on top, fails to arouse the internal female organ sufficiently since the penis cannot be bent and no angle works to massage something the other side of the vaginal wall. The 'cowgirl' style, facing forward or backward, popular from the days of ancient Egypt ([60]), is unlikely to satisfy the male urge to thrust and likely to exhaust the girl. Its variant, the lateral coital, with the woman lying on top hips joined but torso angled away, suffers from the same issue. It is also complex, confusing, needs extensive practice to get right and would still leave her half aroused because of the wall and hood skin blocking getting to hers. Women moving around can make it harder for men to keep the penis inside the vagina. The mainstream in major cultures prefers the man-in-control male-superior position for good reason. Kinsey found the majority went for the missionary position in this country. Anthropologists expect that to hold for other cultures as well.

To sum up some females now partner with males for gratification instead of adding a vibrator. However men do not seem naturally inclined toward, or to get pleasure from, inducing orgasm in women. Delaying can make it harder to ejaculate at all. M&J:

"Primarily, male failure in coital exposure has been concentrated in the areas of erective inadequacy. Failures have developed either in attaining or maintaining penile erection to a degree sufficient for mounting effectiveness." One presumes mounting effectiveness is getting the woman to reach orgasm, since in the next line, they point to premature ejaculation as the second concern. The group was trained to hold it in long enough to get the woman to climax: "Premature ejaculation has not been of continuing concern, once adequate technical and clinical suggestions have been made, accepted, and practiced."

So what about the studies and surveys which show women reporting they are satisfied with orgasm from intercourse? Hite and other feminists questioned inflated orgasm-from-plain-intercourse figures in the 70s, by showing most included foreplay or hand-assist in defining intercourse. Her own figures were less than 30%, but that included foreplay, and a biased sample who believed intercourse should lead to orgasm. But almost 40 years have passed. Are the studies better now? Elisabeth Lloyd in her recent *The case of the female orgasm*, 2005, summarizes such studies. Her central theme is not orgasm and intercourse, which makes the data agenda-free. She concludes: "In sum, it seems that approximately 25% of women always have orgasm with intercourse, while a narrow majority of women have orgasm with intercourse more than half the time. From the studies reported, roughly one third of women rarely or never have orgasm with intercourse . . . " This is after including foreplay and various sex positions in the definition. And for a Western population taught and trained the need to make sure the woman got her pleasure. The numbers from straight conventional missionary position sex would be lower. Anecdotal evidence and surveys indicate for other cultures, where men do not feel ethically responsible for pleasing the female sexually, numbers are likely to be more reduced.

Looking at vibrators, common ones work differently from a penis which can only thrust. Hitachi's magic wand is an example. It has a ball at the end, which vibrates. The wand massages the clitoral bulb from the outside, and is not meant to be inserted. The penis is, and cannot move sideways, let alone vibrate, providing guys little voluntary control.

Women can fake orgasm by controlling breathing and vaginal muscles. Some do it as they feel grunting and panting please their partner. Others to make their guy feel satisfied.[37] On the other hand, men's delight at getting a partner to reach her peak is learned. Half of it could be the myth making a she come proves his virility. And half the hope, after the bliss, she is more likely to agree on other things. Long-term monogamy may make a wife come faster, but as we will see later, leaves the husband bored.

4.2 Sex surveys

Why are numbers in sex surveys for orgasm from intercourse so inconsistent? There is a history of glorifying vaginal orgasms, even after science proved it did not exist. Psychologists from Freud onward considered women who do not come during intercourse as mentally flawed. Dr. Seymour Fisher in *Understanding the female orgasm* would state: "A favorite theory, particularly popular in psychoanalytic circles, is that the woman who cannot reach orgasm is psychologically flawed . . . It is assumed that only an orgasm produced by the movement of the penis in the vagina is a mature form of sexual fulfillment. Orgasm produced by manual or oral stimulation of the clitoris is labeled immature. A woman who does not achieve consistent vaginal orgasm is regarded as maladjusted."[38] While science has moved on, the popular idea remains straight sex should get a woman her pleasure. The male-superior position dominates the cultural milieu. Women become pressured into proving they are ok with straight sex and a quick climax. We all like to believe our pleasures are as good as anybody else's, and hence many women try to catch up with others by arbitrarily deciding what they felt had to be the thing. To quote Lloyd: "Ever since Freud, there has been a heavily normative equation drawn between a woman having orgasms with intercourse and her true womanliness and feminity, thus producing great pressure on women to have orgasm with intercourse." Or at least to report one. She also points out: "People often, sometimes even unconsciously, try to tell the interviewer something that would put them in a good light." Kinsey tried to correct for such biases, but the self-reporting bias has been ignored in many later studies. Lloyd points to one study by Laumann which had men reporting approximately 75% more partners than women, a physical impossibility (p. 42).

Kinsey spent considerable time honing his interviewing skills.

He devotes almost 150 pages of the book to describing the techniques he used to collect data. He notes how important it is to establish rapport before an interview on a subject like sex, and how much time it takes to learn this skill. He also assumes a sample size of about 300 is needed to be sure of the conclusion statistically. The newer research, quoted by Lloyd, consists of scattershot studies, based on either questionnaires or interviews. For direct experimental observation, the standards set by M&J were of clinically observing thousands of orgasms over years. The studies, largely in lightweight journals, on rates of the female climax, based on surveys mailed to a few hundred people or monitoring less than a hundred volunteer couples, assume people speak the literal truth. Lloyd's book collects such surveys together, and shows how small the samples mostly are.[39] Cultural influence is so ingrained many just give the answer which goes with the flow. Since people know results of surveys affect attitudes and thereby our way of life, they often give politically correct answers to be safe. Making a survey anonymous leaves this bias intact, since many will still worry about what they contribute to the overall result and its effect. Studies on sex are also biased by how people interpret questions. Women often consider any slight throbbing they feel the thing, artificially raising the reported numbers of those who climax. Most get pressured into assuming they too have orgasms because of the high figures in reports they see. Corrupting numbers more in further studies. Such surveys set a hard-to-reverse trend of subtle exaggeration. In addition, a few women worry about losing equal rights if surveys and discussions change the status quo on our sex mores. These self-reporting errors were known to Kinsey, which made him rely on direct interviews. But interviews are costlier and take longer, with the Kinsey study taking almost 10 years. By and large, newer researchers do not have that luxury, and the survey bias stays high.

With mores being what they are, volunteers for sex experiments represent a minority apart from the mainstream. Most of the volunteer studies referred here used university students. Kinsey noted groups behaved differently on sex, and the college-educated class was to be considered a distinct group. Experiments which stay inside accepted cultural norms also mix up cultural and biological variables. Scientists would hardly conduct, let alone publish the result of, an experiment in free sex among a group chosen uniformly from a worldwide population.

Cross-culturally, rates of orgasm from intercourse are lower. A general view is other cultures bias girls against their pleasure, and hence studies on them are meaningless. We forget the West culturally educates them to tie their pleasure to sex with men. Making studies here as well mix up culture and biology.

4.3 Sex urge

Historically the sex urge has never been defined precisely, neither for men nor women. Many encyclopedias define it as 'libido', a complex concept popularized by Freud and Jung. Some other definitions, such as a need for sexual activity, just shift the debate to what sexual activity means. Most definitions conflate what we have innately with what we learn culturally. For the physiology of sex, I relied on anatomy. But the nature of the sex urge is better analyzed with biochemistry more so than anatomy.

4.3.1 Biochemistry

Hormones control or add to the various stages of the urge and orgasm. Their exact nature and working are still being studied. I will refer to articles and published papers to analyze the hormonal biochemistry of the drive and pleasure. The study of hormones comes under the subdivision of biology, endocrinology, and the study of action of hormones in the brain under neuroendocrinology. The papers referred to are from these fields.

I will start with the male urge. Erection is known to be innate, since nobody teaches us how to get erect. Nothing beyond that, including how to have sex, can be considered intrinsic. Hite quotes Yerkes and others to show even chimpanzees and some other animals must learn to have intercourse.[40] Chimpanzees brought up away from their peers, not seeing any sex act, do not know how to mate. Unlike rodents, for which mating is hardwired.

Evolutionary psychology assumes a trait gets to be hardwired only if a must. A trait, originally learned, will become hardwired only if the species ends up in an environment where the trait does not get taught or learned. In that case, those with genetic mutations hardwiring the trait become more fit, causing the hardwiring gene to spread. If the species is always in an environment where the trait is taught and learned, a mutation hardwiring it is no advantage, and even might cost more energy in the brain. The mutation will not spread.

In the line dividing from a common ancestor to chimpanzee and man, in the natural environment, all offspring have been raised learning the way of sex from adults. Both primate and early human societies have never raised infants totally isolated from this knowledge. So, if in chimpanzees a particular way of sex is not hardwired, it is likely so in humans as well. A particular way of sex, including straight thrusting into a vagina, is unlikely to be inborn for us.

Once we learn a particular way, we stick with it if it is pleasurable, since the pleasure-seeking centers of the brain will enhance the craving. It is reasonable to assume the female drive works the same qualitatively. This dividing of the full sex act into two parts is not new. Evolutionary psychology has the similar ideas of appetitive and consummatory behavior.

The memory of how good sex was before does qualify our urge the next time around. It also decides how we plan to satisfy it. For men the feeling to thrust is probably so learned, though the learning is eased by a supportive anatomy and biology. It likely cannot be unlearned except by wiping memories. The effective biological urge hence mixes innate and learned elements both wired into the brain.

One way to understand this is to look at the role of hormones. A number of them are involved some way.

4.3.1.1 Hormones for the innate drive

J. Bancroft of the Kinsey Institute in Indiana University summarizes *The endocrinology of sexual arousal* in the Starling Review, in a 17 page article. He concludes: “The evidence is fairly clear that in men who have gone through normal puberty and who have not yet been affected by aging, testosterone plays an important role in their sexual interest and associated sexual arousability.” This follows from castrated men, who lose testosterone-producing testicles, losing arousal unless testosterone supplements are given. That this androgen is the primary innate male sex drive hormone is fairly well established.

In women, the results of studies have been mixed. Bancroft:

"... in several studies of younger women, the relationship between testosterone and sexuality was most apparent in women whose sexuality was unproblematic." Since women's sex organs are the same as men's but positioned differently, it is reasonable to assume testosterone is their drive hormone too. There are some studies which show androgen supplements boosting women's drive, but estrogen not doing so, but the issue is not considered settled. The article is recent: *Combined esterified estrogens and methyltestosterone versus esterified estrogens alone in the treatment of loss of sexual interest in surgically menopausal women*, by Warnock JK and others, *Menopause*. Since testosterone changes or aromatizes to estrogen inside the body, which incidentally is how ovaries produce estrogen, one can question whether the supplement ended up being an estrogen one. However, similar results have been obtained with another version, DHT (DiHydroTestosterone), which behaves the same, but does not aromatize. What is clear is the female reproductive hormones, estrogen and progesterone, are not directly related to the sex drive, since removal of the ovaries does not reduce the drive, though it ends estrogen production. Menopause also ends estrogen production, but has no associated drive reduction apart from the shrinking of many sex organs (M&J Chapter 15, The Aging Female). In those cases where menopause does affect the urge, T is often added to estrogen hormone replacement therapy. Estrogen is supposed to improve drive only indirectly by improving general well-being.

Way back in 1974, Kaplan had this to say, on p. 33: "Finally, male and female libido and sexual functioning are multidetermined. Both are ultimately dependent on androgen, as well as on psychic determinants." Again, on p. 50: "Androgen appears to have specific effects that enhance the erotic drive of both sexes. This is well documented and may be considered as established fact ... A review of the literature of both man and animal studies indicates that estrogen and progesterone may have no specific effect on sexual behavior." Fast forward to 2007, *Evolutionary Cognitive Neuroscience*, edited by Platek, Keenan and Schackelford, p.247:

> The androgens, particularly testosterone, are central to the sex drive in both men and women . . . Middle aged women who inject or apply testosterone cream to the skin boost their sexual desire . . . Many women feel more sexual de-

> sire around ovulation, when testosterone increases. Both sexes also have fewer sexual fantasies, masturbate less regularly, and engage in less frequent intercourse as they age and testosterone levels decline . . . testosterone is central to the sex drive.

4.3.1.2 Hormones which reward learning

Dopamine (DA), norepinephrine (NE) and epinephrine (EP), better known as adrenaline, are the three main catecholamines. They are involved in responding to stress and so peripherally affect all urges. The hormone DA is also involved in predicting reward errors, that is in learning and remembering the pleasure associated with activities. Researchers believe DA does not control the pleasure itself, just the memory which eventually leads to a craving for it. It controls the learned part of our cravings, whether it be for food, sex or drugs, by encoding the reward system in the brain.

Oxytocin (OT) is supposed to provide pleasure by reducing stress, and that way promote bonding. This is speculative. Its main function is to contract muscles during labor, and maybe during orgasm.

Prolactin (PRL), as the name implies, is related to milk production. There is a theory it might also signal the body is done with a pleasure, satiated by orgasm, for example.

T.H.C Krüger and others have found increases in OT and PRL immediately following orgasm (*Specificity of the neuroendocrine response to orgasm during sexual arousal in men* in the *Journal of Endocrinology*). That paper covers only the male response, and the OT rise is not statistically solid. In *Psychoneuroendocrinology* is another one of their articles *Coitus induced orgasm stimulates prolactin secretion in healthy subjects*. The title sums up the paper, but the data on women are suspect, since the initial difference between the controls and the subjects skews the results. The period when a woman can orgasm again after climaxing once, the refractory period, is significantly lower than for men. An equal PRL jump fails to explain this difference, if PRL is hypothesized to make one feel done. A third, two-sheet article from Krüger, in *Biological Psychology* is titled *The post-orgasmic prolactin increase following intercourse is greater than following masturbation and suggests greater satiety*. It uses the same data from the previous experiment. While the conclusion may be valid for males, for females the previous objections stay. The stimulation for both intercourse and masturbation are essentially the same for women, and they can climax multiply for both cases. Satiety is different across the sexes, and a hormone that fails to reflect it is the wrong one for satiety in women. Bancroft would point this out in his summary.

Many of the original researchers claimed women had no limit. M&J, p.65: "Masturbating women concentrating only on their own sexual demands without the psychic distractions of a coital partner, may enjoy many sequential orgasmic experiences without allowing their sexual tensions to resolve below plateau-phase levels. Usually physical exhaustion alone terminates such an active masturbatory session." What they fail to mention because of cultural sensitivity is that a woman can mate with multiple men to the same effect. Hite: "Sequential orgasms can be continued indefinitely by many women." Sherfey: "Consequently, the more orgasms a woman has, the stronger they become; the more orgasms she has, the more she can have. To all intents and purposes, the human female is sexually insatiable in the presence of the highest degrees of sexual satisfaction." Women have no satiety hormone. Bancroft points out this issue, and suggests PRL rise may be due to suppression of DA, which normally blocks PRL release. Fenandez-Guasti and others showed the satiety mechanism in male rats works by suppressing androgen receptors: *Sexual behavior reduces hypothalamic androgen receptor immunoreactivity* in *Psychoneuroendocrinology*. Primates differ from rats in brain activity during orgasm though.

Nobody has yet found any changes in blood plasma DA, NE and EP after orgasm (Bancroft), even though DA does control the learned part of the urge itself. Since none of these can cross from blood into the brain, being big molecules blocked by the blood-brain barrier, amounts measured in the plasma do not indicate how they affect behavior. Holstege and others reported indirect DA changes, during ejaculation, in the brain as increased activity, blood flow, in many regions including one called the ventral tegmental area associated with dopamine and rewarding behaviors. This paper *Brain Activation during Human Male Ejaculation* in *The Journal of Neuroscience*, also showed brain activation in men during ejaculation was completely different from that of rats. A somewhat similar pattern is reported by Holstege and others in *Brain activation during female orgasm*. DA is activated with sex, and presumably tells the brain to remember the pleasure. This correlates well with the effect of DA on other cravings such as that for food, summarized in *Dopamine, learning, and reward-seeking behavior* by Arias-Carriön and others, *Acta Neurobiologiae Experimentalis*. These papers are not from tier-I journals, as measured by the standard impact factor ranking, reflecting the underfunded and less glamorous state of sexology among the sciences.

4.3.1.3 The combined drive

Dopamine is associated with rewards and hence learning, since rewards follow experiences. Experiences alter testosterone levels as well, but the link is weak. Overall it can be considered coding the intrinsic drive. Analyzing the hormones shows us the mechanism by which two different components, the innate arousal one and a learned craving for a particular act, combine in the brain to generate a single urge. This cannot be broken up into innate and learned components by direct experiments, since we biologically respond driven by the combined urge.

4.3.2 Intensity of the innate urge

The intensity of the urge is not relevant since I focus on its nature. But available data paint a picture different from the popular idea. Women have similar amounts of the reward-related hormones as men. Hence one can reasonably conclude they have the same learned aspects to the sex urge that men do. Women have less T, tens of times less on average. They are more sensitive to the hormone though. Whether they can be innately aroused as easily as men is an open question, since DA and T interact and work in an integrated way, making the two inseparable in direct experiments. Kaplan was aware of the issue:

> Also, the female orgasm seems far more vulnerable to inhibition than does the male's, and while orgastic dysfunction is very prevalent in the female population, its male analog, retarded ejaculation, is relatively uncommon. . . . In general, it appears that the female sexual response is more variable than the male's presumably because it is more susceptible to psychological and cultural determinants. In contrast,

> sexual arousal in the male, especially when he is young, is governed to a greater extent by physical factors, and is less vulnerable, although by no means immune to psychic influences.

Pfizer concluded the same with Viagra. On 28 Feb 2004, the company gave up testing the blue pill on women. The accompanying press release contained quotes from many authorities on sexology. They match what Kaplan said all those years ago.[41]

"There's a disconnect in many women between genital changes and mental changes," said Mitra Boolel, leader of Pfizer's sex research team. "This disconnect does not exist in men. Men consistently get erections in the presence of naked women and want to have sex. With women, things depend on a myriad of factors." Dr. Boolel said that he and his team were continuing their research. But he said the researchers were changing their focus from a woman's genitals to her head. The brain is the crucial sexual organ in women, he said.

In the same article, Dr. George Nurnberg, professor of psychiatry at the University of New Mexico School of Medicine put it better: "That [not focusing on psychiatry] is a mistake with women, because psychology is more important in their sexuality than it is in men's." Dr. Marianne Legato, professor of clinical medicine at Columbia University and director of the Partnership for Gender Specific Medicine, said that the disconnection between arousal and desire in many women was so profound that they "often don't have any desire for sex until they are physically in the act of lovemaking." Indeed, getting a woman to connect arousal and desire, Dr. Legato said, requires exquisite timing on a man's part and a fair amount of coaxing.

Animal studies also point the same way. Female primates have a drive to mate driven by the estrous cycle. However the estrous cycle is dictated by the reproductive hormones, E and progesterone, not by T. Goodall: 'The stages in the sexual cycle are largely regulated by the gonadal hormones: the development of the swelling is associated with increasing secretion and excretion of estrogens in the follicular phases; detumescence, with decreased levels of estrogens and increased levels of progesterone in plasma and urine."[42] The chimpanzee female's heat is biologically different from the human female's sex drive.

Lloyd mentions the low rate of orgasm in other cultures. In p. 115, quoting Davenport: " In most of the societies for which there are data, it is reported that men take the initiative and, without extended foreplay, proceed vigorously toward climax without much regard for achieving synchrony with the women's orgasm." On the next page are two quotes from Qidwai and Chan. The first mentions, among college-educated Pakistani men, only 42% believed women were capable of experiencing orgasms. The second is a 1990 study of Chinese medical students, with only half of the 52 males surveyed agreeing female frigidity was often wrongly self-attributed, while 77% of females agreed.

Symons explicitly distinguishes between consummatory behavior and autonomous libido (appetitive behavior).[43] They map to sex pleasure and sex urge. He considers the male appetitive behavior the result of androgens acting on the developing brain. Page 164: "The evidence is impressive that human males are more strongly motivated to seek sexual intercourse per se than females are." His anthropological roots show in the opening sentence of p. 253: "Among all peoples it is primarily men who court, woo, proposition, seduce, employ love charms and love magic, give gifts in exchange for sex, and use the services of prostitutes." While Symons attracted flak for his views, evolutionary psychologists consider him one of their founders.

In *The Evolution of Desire*, chapter 11, David M. Buss collects research showing a woman's drive varies across the menstrual cycle. The studies do not split the innate and learned part of the drive. The results are not considered settled more than a decade later, since the samples are small and limited to one culture, and other studies contradict the results. *The Handbook of Evolutionary Psychology*, edited again by Buss, reports on p.352, that studies differ on whether women initiate sex more in midcycle. The peak near ovulation also varies between them.

Balanced against this handful of papers is the vast amount of research collected by Symons, Buss, and others on the women's drive differing from men's. As Symons notes, it is men who buy porn magazines, skin flicks. It is largely they who visit prostitutes. Men are aroused by visual stimuli, of attractive women in suggestive dress or poses; women much less so. As we saw earlier, everywhere men make the first move in the mating game. Buss notes men fantasize more than women about sex.[44] On the same page: “The most striking feature of [male fantasy] is that sex is sheer lust and physical gratification, devoid of encumbering relationships, emotional elaboration, complicated plot lines, flirtation, courtship, and extended foreplay.” Women desire even in short-term affairs someone who is kind, romantic, understanding, exciting, stable, healthy, humorous, and generous with his resources. In addition to the physical qualities (p. 88). It is women who use sexuality to manipulate by withholding sex (p. 145), showing the want is asymmetric. In p. 207, “Whereas for men, affairs are motivated mainly by the desire for sexual variety, for women affairs are motivated more by emotional goals and may represent an effort to switch mates while they are still reproductively capable.” The quotes are not arbitrary. They accurately reflect the proportion of ideas in the book which describe the two sides of the coin when it comes to the women’s drive. The Handbook sums up: “Human sex differences [between males and females] in the desire for short-term sex have been observed [meaning men wanting it more] in studies of sociosexuality, motivations for and prevalence of extramarital mating, quality and quantity of sexual fantasies, quality and quantity of pornography consumption, motivations for and use of prostitution, willingness to have sex without commitment, willingness to have sex with strangers . . . ”[45] I dropped the references from the quote. In one particular study, an attractive stranger on a college campus asked somebody from the opposite sex for casual sex. The experiment was done first with women and then with men. All women said no, while 75% of men said yes, and the remaining 25% were apologetic about refusing. Carey notes: “Males are more ready than females to engage in anonymous sex, even to the point of paying for it. Women report more sexual advances made on them by men than men report sexual advances initiated by women. Personal ads written by women request males for relationships more often than those authored by men; men’s personal ads stress sex . . . Males pick a time frame shorter than dating [for waiting before having sex]” [46]

Male rats behave consummatorily when they get erect, mount and ejaculate. This is controlled by the dorsal medial pre-optic nucleus of the hypothalamus. Consummatory behavior for females is defined as lordosis, the receptive arching of the back, and this is controlled by the ventral medial pre-optic nucleus. Appetitive behavior, the drive which leads to arousal and moving toward a mate, is controlled partly by the amygdala, larger in males. In humans, consummatory behavior is likely just the orgasm, since both thrusting and any particular position is learned and have to be considered appetitive behavior (the part that leads to consummation). The medial pre-optic nucleus has one section, INAH3, larger in men than women, after accounting for their bigger brains in general. The amygdala is also sexually dimorphic, disproportionately larger in men. Regions associated with the urge, in both the emotional centers of the brain, and the more reflex-related centers of the spinal cord, differ in men and women. Specifically they are larger in men, with the change caused by T, a hormone more prominent in them both when the brain is maturing and later. The nerves and muscles of erection and ejaculation were detailed in the last chapter.[47]

The lay perception that: 1. In all animals, including humans, females and males have the same urge, with the attraction automagically changed from male to female features, and 2. Until the last century in the entire world, and even now in the non West, women inhibit their intrinsic urge and men lack the technique, are both incorrect.

This take does not affect my vision. However a change in it helps. When we stop practicing our leap of faith over the T gap, we will see more clearly that male sex and female orgasm do not fit or complement each other.

4.3.3 Relieving the urge

Arousal is the tension of erection with its blood flow and muscular tensing. The need to release the tension is the basic urge. We are, seemingly but for men not certainly, born not knowing how to. The best way of sex is hence not based on our innate knowledge; it has to be based on what is easy and a pleasure. Both men and women can masturbate or mate to release the urge. We need to select one of the four possible combinations.

M&J p. 34, 35 Female Extragenital Response:

> Involuntary contraction of the rectal sphincter . . . is a significant indication of the intensity of orgasm. External rectal-sphincter contractions occur most frequently during an orgasm elicited by automanipulation but occasionally have

> been observed during coition . . . The highest cardiac rates have been returned during female masturbatory sequences rather than during coition.

p. 118:

> Although the number of experiments is not sufficient to allow an empirical position, it is current belief that the corpus [uterus] contraction patterns initiated in response to automanipulative techniques are of greater intensity and duration than those resulting from coitally induced orgasmic experience. Certainly it is subjectively true that study subjects report that usually the experience with orgasm induced by masturbation is more intense than, although not necessarily as satisfying as, that resulting from coition.

p. 133:

> . . . the maximum physiologic intensity of orgasmic response subjectively reported or objectively recorded has been achieved by self-regulated mechanical or automanipulative techniques. The next highest level of erotic intensity has resulted from partner manipulation, again with established or self-regulated methods, and the lowest intensity of target-organ response was achieved during coition.

Hite, in the introduction to her book states: "Society has long known that it is easier for women to orgasm during masturbation than coitus." Her figures at the end show almost every woman who masturbated getting to orgasm during masturbation. And almost the very first line of the main text, p. 53: "Masturbation seems to have so much to recommend it—easy and intense orgasms, an unending source of pleasure."

For men the opposite holds. M&J are often misquoted on the issue; they did not measure how intensely males orgasmed while masturbating compared to mating. More recent research has shown men eject more sperm and other components of semen while copulating than masturbating. This is believed to be due to sexual arousal preceding copulation being longer and more intense.[48] Unlike women, men orgasm more intensely when copulating than when masturbating. Probably because the stimulus differs for the two cases. Ejaculation from mating and masturbation are equally easy for men; the rates match in studies.

The four possibilities for orgasms: 1. Both men and women masturbating, 2. Men copulating and women masturbating, 3. Men masturbating and women copulating, and 4. Both men and women copulating, can be summarized now.

1. Men masturbating, women masturbating: Easy for men, easy for women, less pleasure for men, more pleasure for women.
2. Men masturbating, women copulating: Easy for men, hard for women, less pleasure for men, less pleasure for women.
3. Men copulating, women masturbating: Easy for men, easy for women, more pleasure for men, more pleasure for women.
4. Men copulating, women copulating: Hard for men, hard for women, more pleasure for men, less pleasure for women.

The data lead to one logical conclusion. The urge to release the tension of clitoral arousal can be satisfied by stimulating the clitoris further to orgasm. This is best done by women with their hands or a vibrator, since the erect male penis cannot do this effectively. It is hard for the penis to excite women enough to get to stage 3 even once, let alone satisfy their urge for multiple comings. Once the innate urge is satisfied this way, we learn that pleasure via dopamine and oxytocin and will continue doing things that way. A woman's urge is now seen to be masturbatory in nature, since that is how it is fulfilled best. The need to relieve that urge at the same time a man relieves his, is learned and taught.

Men may think the partner's drive complements their own. But this feeling can be shown to be a learned one by analyzing basic biology. The oft-cited female sex drive markers mentioned earlier are difficult to see even in a naked one standing naturally unless you go looking for them. The position of the vagina, the clitoral hood and pubic hair present in the natural state hide them. A he and a she undress after both decide on sex, and sometimes mate at night in dim light. In neither case can he be aroused biologically by her physical sex markers since his arousal would precede seeing the markers. In the second case he would not even see these.

Humans are unique in their sex drive. For other primates, females have a period of heat, estrus, when they have visible changes, such as a bottom swelling for chimpanzees. Females allow males to start sex when they are in estrus. A female in estrus in a group also triggers a vicarious drive, causing other matings within the group.[49] This is true of all non-human apes. Human females have no estrus showing they are receptive. Men feel attracted to women throughout. Biologically a man's arousal is independent of any signal of the partner's feeling to mate. He does not get turned on seeing her turned on.

4.4 Sexual selection

Sexual selection by females, making a species fitter, describes what might have happened as life journeyed from amino acid to humans. It is not a rule we are required to follow. Natural selection, of which sexual selection forms a part, is complex. Evolutionary psychology's conclusions on the female drive are different from the popular one. The male and female drives are expected to be fundamentally different, as explained in Section 1.3.8 on page 28.

4.5 Mood to give sex

As the quote from Lloyd showed, most of the world hews to a he starting sex and getting a she to agree. That mood to agree is not proactive, it reacts to the male one. Science recognizes a sex drive, not a responsive mood. One could reasonably claim women need to be calm and content to mate, but then we need to be calm and content to do anything effectively. The ideal world seeks to get the time and the number of people calm and happy to its greatest number.

4.6 Comparing to animals

Animals are used as models for studying both genetic and hormonal interactions. Commonly the roundworm, also called a nematode, (*C. elegans*, short for *Caenorhabditis elegans*), the fruitfly, *Drosophilia Melanogaster*, and rats are used for both genetic and psychology tests. Specifically on the sex drive front, one needs to be aware of the differences between these species and humans to correctly parse the published work.

4.6.1 Nematodes

The nematode is hermaphroditic with both testes and ovaries or male with just the testes. There are no females. Hermaphroditic nematodes fertilize sperm and eggs internally or mate with males. The nematode has a total of 959 cells, and 302 neurons. It has no Y chromosome. Hermaphrodites have two X chromosomes, while males have only one. The ratio of X chromosomes to the number of sets of autosomes determines the sex. A ratio of 1 results in hermaphrodites and a ratio of ½ in males. In terms of evolutionary lineage, phylogenetically, nematodes are far from humans and this is reflected in their sex differentation. It is difficult to extrapolate mating behavior of roundworms to humans.

4.6.2 Fruitflies

The fruitfly sex chromosome is generally similar to that of humans, with males being XY and females XX. However sex is actually determined by the ratio of X chromosomes to the number of haploid sets of autosomes. Ratios greater than or equal to 1 yield females, and lower ratios males.

4.6.3 Rats

Rats, being mammals, have the same sex chromosomes humans do. However, sexual behavior is more hardwired in them. Rats mate only when the female is in heat. When receptive, the female arches her back up to indicate she is willing, an instinctive behavior called lordosis. Stimulating the cervix releases the hormone PRL which is required for the ovum to get to and embed in the uterus. Male rats feel a sex drive only for female rats in heat. The scent of a new male aborts the pregnancy of a female.

Rats do not produce androgens from the adrenal gland, unlike humans. A castrated rat has no testosterone produced in its body.

Rats and mice are also driven by pheromones and a special sensory structure, the VNO (VomeroNasal Organ) which detects pheromones. Input from the VNO goes to a different brain region than from the rest of the nose, called the accessory olfactory bulb. When a gene which codes for this pathway, the TRPC2 gene, is absent, male mice mate indiscriminately with both females and males.

Humans have a VNO but with no sensory neurons and nerve bundles. The accessory olfactory bulb is non functional—it exists in the fetus but does not develop later. Almost all pheromone receptor genes in humans are also non functional (115 out of 117). The pheromone system of rats does not exist in humans.[50]

In the rat brain the hypothalamus controls mating behavior. One part, the rostral medial zone plays a large role. The medial preoptic region controls male sexual behavior including erection, mounting and ejaculation. The ventral regions control female sex behavior, such as lordosis, the receptive arching of the back. These differences result from exposure of the brain to testosterone in the womb. Clearly in rats the male and female drives are completely different, both in behavior and the brain. The size and pattern of serotonin-carrying neurons (serotonergic innervation) is sexually dimorphic, that is they differ between the sexes. To quote from [79] where this data is derived from: "The possibility that similar dimorphisms are present in the human hypothalamus is supported by the identification of a region of the human preoptic region that is approximately twice as large in males as in females." This is speculative since rats mate differently from us. Appendix A on page 349 details what is known of the structure and function of the hypothalamus in humans.

4.6.4 Chimpanzees

Chimpanzees also lack a VNO. But the anatomy is different from humans for both males and females. Males lack a true glans penis, have only one corpus cavernosum, and have a penile bone, the os penis. The penile ending has more sensory nerves enabling males to ejaculate faster, typically in 10 seconds. The females have their clitoris closer to the vulva, with no urethral orifice in between. Straight copulation is more likely to excite the clitoris, though no study has shown they orgasm that way. Being quadrupedal, walking usually on four legs, hey mostly mate in the dorso ventral position, doggie style. The bonobo can mate ventro ventrally, face to face, but the general anatomy is similar to the chimpanzee. The hips of chimpanzee and bonobo females have less fat allowing easier access to the vulva from behind. Both have swellings during their ovulatory cycle, which is when most matings take place. Both menstruate in the sense they get rid of the egg and lining the way humans do, but they have estrus in the form of the swelling indicating ovulation.

4.7 The new way

Looked at a little less academically, mixing up the stages of M&J, the female pleasure commonly refers to:

1. Clitoral orgasm after the clit (clitoris) is engorged with blood. Others, including the disputed deep vaginal one, are variants

exciting the clit peripherally, since only it is capable of an orgasm.

2. The warm feel of touch carried by nerves throughout the body including the vulva—vaginal lips, clitoris and the clitoral hood.
3. Flushed feeling from more blood flowing to various parts including the vulva.
4. Vagina getting moist from droplets seeping in from blood vessels through the walls.
5. Expanding vagina.
6. Taut breast and erect nipple.

Of these only the coming is a real pleasure. The rest are physiological changes thought of as joys because they hold the pleasure of a promise. Desire waiting to be fulfilled is enjoyable when it does get fulfilled. When thwarted it is no longer a joy. Foreplay is nice when it ends with the proprioceptive feeling of the muscular contractions, and relaxing of tension, of the climax.

Of the rest, considering sense of touch a sex pleasure is a stretch. Women have only as many nerve endings per square inch of skin as men. So what they feel when touched is the same. A flushed feeling does not qualify as a joy either. It comes from a rush of blood, similar to a face getting red, and we hardly feel it. A moist vagina being a pleasure overstates it; we wet ourselves when we sweat. It can be induced to secrete by playing with a finger. No bliss is associated with the vagina dilating during intercourse—it has few nerve endings and can be expanded by inserting and slowly thrusting any right-sized object. Taut breast and erect nipple are physiological changes and little more. Even men are supposed to feel this when aroused, but few as much as recognize it. Intense research likely would add to the list of physical changes from stimulating the vulva. By themselves physical changes are no sex pleasure.

Which leaves the clitoral part. Feminists such as Koedt and Sherfey stated only this is gratifying for a she, and I agree. They believed this should be linked to male pleasure. I disagree. Their linkage was on psychological grounds, not biological ones. Sherfey on p. 122: "Masturbation is a lonely affair. . . . In other words, women will usually prefer vaginally induced orgasms, but not because the sheer physical pleasure is greater." But because of emotional reasons. Hite, who is normally clinical in her observations, on p. 12: " . . . there is something very symbolic about being penetrated by another, as men too can experience." Note how much of a stretch this is. As any man who has used an enema can attest, male penetration is not symbolic, it is painful, since men do not have an opening like the vaginal one. Again, on p. 25: "Actually, as will become apparent in other chapters, the emotional context is the primary value of intercourse for most women." Hite, Koedt, Kaplan and Sherfey glossed over how their own description of the female drive as insatiable, with the ability to orgasm multiple times, meant the erect penis was not the tool to satisfy it. As Hite herself would state, p. 311: "There is no organ especially concocted to fit the clitoral area and the kind of stimulation we generally need for an orgasm."

One could argue this view is restricted to feminists. Symons, responding to Sherfey: "The sexually insatiable woman is to be found primarily, if not exclusively, in the ideology of feminism, the hopes of boys, and the fears of men."[51] But he did not consider female orgasm naturally resulting from intercourse. He did not argue in terms of anatomy but from cultural data he had access to as an anthropologist. The foremost in feminist ideology, EP and anthropology all agree straight intercourse does not, by and large, get females to orgasm.

Female orgasm is masturbatory and should be untied from sex. Males ejaculate either by thrusting or rubbing directly or indirectly. Most consider thrusting which needs a female, sex, and the other masturbation. The clit cannot thrust, which makes its climax masturbatory. A girl should climax alone with a vibrator, as a guy finds it hard and unnatural to help her. Guys, on the other hand, should not have to masturbate because women can satisfy them easily. There are many tutorials on how a he can help a she to reach climax, but none mention why he should. That is because it is not a scientific fact but rather a faith. Speaking at the level of faiths God programmed us to go for our wants naturally and easily, with no separate educated and uneducated versions for something as basic as sex. For a man to be a male no training is required.

Female arousal is not required for male sex. The penis can enter the vagina even without the woman being aroused. Expansion and lengthening during the initial part are of the inside vagina close to the uterus. The entrance opens up enough for the penis to enter. This is because the entrance is technically not an opening but an introitus. The walls of the vagina are collapsed together in the resting state, with no space between them. When the penis slides in, the walls are stretched apart by it. To quote M&J, p. 194: "Full accommodation [of the penis by the vagina] usually is accomplished with the first few thrusts of the penis, regardless of penile size". They do mention two women with exceptionally small vaginas who had trouble with penetration. But this 0.5% occurrence rate (there were 382 subjects in total) should be considered abnormal, to be included in cases with genital disorders. One also assumes they had not given birth yet (nulliparous in technical terms). Sexologists such as Kaplan did insist men arouse women before penetration, but based more on convictions than biology.

The vaginal barrel is lubricated by mucus even when not excited. The penile glans is smooth and the natural shaft glides within the soft shaft skin, avoiding friction with the barrel. The automatic female response includes more blood flowing to the vagina, which then gets moist on its own.

Foreplay without getting a woman to orgasm is worse than no stimulation, since it leaves blood vessel congestion in the sex organs intact. The physical changes of the excitement and plateau phases are not standalone pleasures, orgasm is the real pleasure. Arousal with no final orgasm is not enjoyable except when taught it is a joy, and if repeated often, can be painful. M&J, on page 119, mention the case of a prostitute who had five plateau-phase experiences ending up with gross vascocongestion and complaining of pelvic fullness, cramps, pressure and backache. Hite, in a harsh mood, calls foreplay without orgasm inhumane. While an engorged vagina might be a tighter fit for the penis, the male glans is only weakly touch sensitive, and the real pleasure is of the climax from thrusting.

We saw pain during sex, dyspareunia, as a female sexual disorder. Sexual arousal, and the clitoral response, does not help with this medical condition. Whether the woman is clitorally aroused with the super-added pattern, or is exhibiting the basic pattern, makes no difference.

So, taking the facts and throwing out tradition and culture, what is maximally convenient and pleasurable to both sexes? A mode of sex where men enter gently without exciting the clitoris, thrust and come, and women, when they want, get their arousal and multiple or sequential orgasms on their own without a man's aid. One could assert an additional point: since men's want is copulatory and women's masturbatory, men can fulfill their urge universally free at no cost to others. But my analysis has focused only on the sex drive and pleasure. There are other costs to women from men mating free: dislike or lack of love getting in the way, lost time and cost of pregnancy, taking care of children, support when old or ill, sexually transmitted diseases, and so on. An ideal world may need balances. Our psychological mechanisms are likely the clue to what those should be, since fundamentally they drive behavior, within the physical environment.

4.7.1 Accounting for jealousy

Such a mode of sex accounts for our EP traits of mate guarding and jealousy. For males to spend more time guarding mates, the effort for other matings should be high, and the fertile period for females, when they have to be guarded, small. This would stop males from trying to mate elsewhere and focus on guarding their partner from mating with others. The adaptation of male mate guarding is influenced by the length of the estrous period (which indicates fertility) and the environmental cost to mating elsewhere. We can infer this by looking at the behavior of other species. In the species closest to us, the bonobo, the fertile period indicated by a swelling on the bottom is long, perhaps the longest in non-human primates.[52] Males tend not to guard females, with no consortships and males rarely trying to stop others from mating.[53]

In us, the fertile period is not externally visible. This means a male who needs to guard a female to prevent cuckoldry needs to guard her throughout. The cost is high, even higher than the bonobo. Biologically, men have the drive to mate elsewhere. They get bored with the same partner and are more aroused with novel partners, the Coolidge effect. Sexual guarding among men, driven by the proximate trait of sexual jealousy, is from an environment which blocks them from mating with other females. Even though biologically the cost of guarding is high, we have an environment which makes the cost of seeking other partners even higher, thus forcing guarding and hence jealousy. The ultimate function of mate guarding, evolutionarily meaningful, is enforced by the proximate trait of jealousy. This trait is not directly coded as an instinct; it is an adaptation triggered by social cues and modified (calibrated) by learning during childhood. The proximate trait of jealousy will not be triggered when people mate free, as we will see later. The trait of jealousy will not re-evolve either, since the ultimate function is better served by men focusing on mating elsewhere; the cost of guarding being too high.

4.7.2 Accounting for short-term mating preferences

Preferences come from having to make choices, because of the costs involved in getting pregnant. The likings are also modified by learning and conscious input. Women have attractiveness likings for short-term flings because they know subconsciously they might to have raise a child of the union, and so need to choose the best one to have a son or daughter with. This mechanism is triggered after a woman decides to go for a fling, which is more than just sex. Few women, unlike most men, consent to sex with a stranger.[54] Short-term mating, for women, still involves the idea of a potential long-term mate. The ideal world should have no short-term mating in this sense, with the sex want defined clearly as presented earlier.

If women are to get past their preferences, societies should have alternatives to the problems they solve by preferring only some. Women prefer certain type of men for mating primarily because they have to bring babies up, that is pay the cost of subsequent birthing. A woman's mating preferences are controlled by knowing they are responsible for bringing up babies. An ideal world hence should not hold them responsible for this; the alternative being group care. Birthing is still a woman's to do, but not caring and feeding the baby. The ideal world should also minimize the variation in many of the traits, especially facial symmetry, related to developmental issues such as nutrition. If we do not want women choosing on the basis of race, we should make the phenotype of race vanish. Short-term mating preferences will then not be triggered, since short-term mating, talking to get to know the guy and trusting him and then mating, will not exist. This follows from short-term mating, as mentioned earlier, being driven by the mechanisms of pleasure, need to switch mates, acquire resources, or to rehearse for long-term mating. Sex should be just the biological act.

4.7.3 Why negative EP adaptations will not matter

Evolutionary psychology centrally assumes our psychological adaptations arose in an environment where men competed for mates. Natural selection is driven by some replicating their genes more, and so mating strategies of a society influence it. Hence most adaptations would activate on inputs tied to mate access, directly or indirectly. They are tied to controlled sex. The easiest way to block their activation is to build a society where sex is free. One particular adaptation we carry, the ability to plan and change societies, can render the others moot. Not by using conscious overrides of the outputs of our innate mechanisms, but by building a society which cuts off their input. Specifically by changing the preferential access to the sex want, at the root of natural selection. I will point out detailed examples along the way to buttress this general point. Discoveries of new adaptations cannot upset this argument, since this defense is based on the general theory the EEA was a society built on competing for mates, and adaptations originating there would trigger on inputs directly or indirectly related to that. Evolutionary psychology allows no spontaneous mechanisms which generate output independent of cueing input.

5 Eating and drinking: body fluid homeostatis

We eat and drink to the keep the fat, nutrient and water content of our bodies, present in skin, muscles, bones, blood, organs and the like, in equilibrium. We feel the need to eat and drink when the brain decides the body is short of fuel.

5.1 Basics of the digestive system

The food we swallow goes down the food pipe, the oesophagus, to the stomach. The stomach mixes it with enzymes and acids such as pepsin and hydrochloric acid to break it down. The processed semisolid food then enters the small intestine, where it is mixed with bile, pancreatic secretions and more enzymes and gets digested and partly absorbed though small hair-like blood vessel coverings called microvilli. The hepatic portal vein carries the blood with the absorbed food to the liver, where it is filtered and processed more. Some of the food moves from the small intestine to the large intestine where the waste is compressed and eventually ejected through the rectum. The movement of food through the intestines, peristalsis, is controlled by the muscles of the intestines. Digestion starts in the mouth where the saliva starts the breakdown of carbohydrates. Saliva makes the mouth and throat slightly acidic; the stomach is strongly acidic, and the small intestines neutral because of bile neutralizing the acids. The large intestine has large numbers of microbes, bacteria, which aid in digesting whatever the stomach and small intestine did not.

The main molecular components of the food we eat are carbohydrates, proteins, fats, vitamins and mineral salts.

5.1.1 Carbohydrate digestion

Carbohydrates come in two basic forms, sugar and starch, sweet and non sweet. Table sugar is the chemical compound sucrose. It is broken up into glucose and fructose in the small intestine, and absorbed into blood. Milk contains another sugar, lactose, split into glucose and galactose by the enzyme lactase in the small intestine.

Starch, the carbohydrate in grains and potato, goes through a two step process. Amylase, present in saliva and pancreatic juice, breaks it into maltose, malt sugar. Another enzyme in the small intestine, maltase, converts maltose into glucose, which is then absorbed into the blood.

The sugars that the blood can absorb are monosacharrides. These contain just one sugar molecule. Examples are glucose, galactose and fructose. Sucrose, lactose and maltose molecules are disacharrides containing two sugar molecules. Starch is a polysacharride containing many sugar molecules bound together. Fiber found in fruits and vegetables is mostly cellulose, a large carbohydrate we cannot digest.

5.1.2 Protein digestion

Protein is found in meat, eggs, beans and similar food. Several enzymes in the stomach and pancreatic juice in the small intestine cleave the proteins into small amino acid molecules. Which are then absorbed into the blood.

Proteins consist of many amino acids linked together. Short proteins are called peptides. The blood absorbs mostly single amino acids, and the enzymes which break the peptide bonds are called proteases or peptidases.

5.1.3 Fat digestion

Fat molecules are dissolved in the small intestine by bile produced from the gall bladder. Pancreatic and other enzymes break up the fat into fatty acids and cholesterol. These molecules pass through the lymph system to the veins of the chest, where they are absorbed into the bloodstream.

5.1.3.1 Vitamin digestion

There are two main classes of vitamins—the water soluble vitamins B and C, and the fat soluble vitamins A, D, E and K. Fat soluble vitamins are stored in the liver and the fatty tissue, but water-soluble vitamins cannot be stored. They have to be continuously replenished.

Vitamin A, retinol, is generated by the liver converting carotene, found in green vegetables, or retinyl esters, found in milk and eggs. Vitamin B12, cobolamin, is absorbed by intrinsic factor, a glycoprotein produced in the stomach. Most animals and plants can make their own vitamin C, ascorbic acid, but none of the apes or humans can. Vitamin D2 can be made by the skin from sunlight, specifically the ultraviolet portion. The kidneys synthesize either

D2 or D3 into calcitriol, which is the form the body needs.

5.2 Cooking

Humans cannot eat meat or most plants raw. Our teeth are not suited for chewing such food. The enzymes in our stomach cannot digest most raw food.

By all accounts, cooking started before our species, H. sapiens, evolved. This was probably done with fire, that is boiling, roasting, baking, grilling, sauteeing, steaming and frying. But making food digestible does not require fire. Powdering, mashing, marinading and soaking would also work to make many plants and grains edible. Cooking makes food digestible by destroying skins and husks, bursting cells making its contents available, modifying the structure of proteins and starches, reducing indigestible molecules into smaller ones, and deactivating poisons. Many plants have developed defenses against being eaten raw by herbivores, and cooking technology, with or without fire, gets past them. Cooking increases nutrition content of the food, and speeds digestion.[55] When done with heat, it also kills microbes.

Reflexes of swallowing and vomiting....

5.3 Hunger and satiety in neuroscience terms

When do we eat? Mostly when hungry. When do we feel hungry? Food intake is coupled with hunger, satiety, internal caloric supplies and need to maintain a stable body weight. Stress makes us eat less. Women who are pregnant or lactating eat more. They need to.

There are two models to explain when we feel hungry and when done. The first is the depletion-repletion model which says we get hungry when the fuels of glucose or lipid which produce energy, go low in some tissues, and when stored energy in fat tissue (adipose tissue) is depleted. When the levels are back up, we stop eating. The principle is we get hungry when the I-am-done signals (satiety stimuli) from the previous meal gradually vanish. We may also eat based on social and cultural habits. The need to maintain caloric energy output steady, caloric homeostasis, does influence hunger, but only indirectly.[56]

We will look first at the basic mechanisms of caloric homeostatis, and then the neural systems influencing and regulating it.[57]

5.3.1 Caloric homeostasis

We get usable energy from three major nutrients—carbohydrates, lipids and proteins. Most tissues can oxidise a specific carbohydrate, either glucose, or lipids in the form of free fatty acids. The liver needs lipids, and the brain needs glucose. One or the other will not do. The first for proper functioning, the second because of large energy requirements. The most important goal of caloric homeostasis is to make sure there is enough glucose supply to the brain.

Homeostasis is a balance between different states. For eating, the two states are the fed state and the hungry state. The jargon has these the prandial and postabsorptive states, but I will stick to the common terms.

Many tissues store carbohydrate as glycogen, a form of glucose, with the liver and voluntary muscles having the largest stores. Energy is stored more efficiently, in fat tissue, as triglyceride. The liver and fat tissue convert carbohydrate to lipids and glycogen, during the fed state. Glycogen is converted back to glucose in the liver during the hungry state.

5.3.1.1 Hormonal control

Insulin, a peptide hormone secreted by the pancreas, is key to hunger and satiety. When a hungry person smells a meal, the forebrain detects the smell and signals through the hypothalamus to the dorsal motor nucleus in the brain stem. The brain stem signals cholinergically, that is using the neurotransmitter acetylcholine, to the pancreas, which secretes insulin. The same pathway is invoked when we taste food. This is the cephalic phase of insulin secretion. Insulin prepares the body for entry of fuels from the gut.

As food enters the stomach, digestive enzymes are activated and these stimulate more insulin secretion. As the food enters the small intestine, the part called the duodenum, nutrients absorbed into the blood trigger more insulin secretion by directly affecting the pancreas. This is the substrate phase of insulin secretion. It lasts well past the end of eating. When insulin eventually is removed from the blood during the hungry period, we feel like eating again. This hormone is pivotal for storing calories in the fed state, and its absence allows stored calories to be mobilized as fuels during the post fed state.

Body fat, adiposity, influences how much insulin is secreted. Thinner people have more insulin receptors on voluntary muscles and fatty tissue. Leaner people secrete less insulin, since the larger number of receptors makes the effect be similar.

5.3.2 Food intake

We consume food in distinct bouts, meals. This is common to all animals. In the natural state, where animals eat when hungry, meal sizes are unpredictable. After larger meals, the next meal is likely to be farther out in time. Eating is inhibited by signals proportional to the size of the meal. These signals come from the stomach, how full it is and what it is digesting; from the intestines, liver and blood, on how much we have eaten and how many calories that would be; and from body tissue trying to keep weight constant.

5.3.2.1 Stomach full signal

The stomach wall has many stretch receptor nerve endings which become more active as the volume of the tummy increases. Gastric distension signals carried by the vagus nerve gets to the nucleus of the solitary tract in the brain stem. From there they go to the hypothalamus, the main area regulating hunger and satiety. They also travel to the seat of awareness, the cerebral cortex, where we feel the stomach ballooning. These signals do not depend on what we eat and cannot make out the difference between food and water. Rat pups stop suckling when their stomachs get full, independent of the calorie content of what they are drinking. In a natural environment, since the pup's diet, the mother's milk, is a known quantity, just volume is good enough as a satiety signal.

5.3.2.2 Digestive enzyme signals

The intestinal small protein cholecystokinin, secreted to digest meals, acts on receptors on the vagus nerve fibers. The same nerve fibers carrying the gastric distension signal. The enzyme signal has information on the calorie content of the food, since the amount of enzyme produced would be enough to digest the nutritional part of the food. This modulates the pure volume data in the gastric stretch signal. Rat pup's decide when to start suckling based on both the gastric stretch and enzyme signals.

5.3.2.3 Signals from digestion past the stomach

The liver provides another I-am-done signal for eating. This comes from the vagus nerve fibers which come from the liver, the hepatic vagal afferent fibers. When the liver's absorption slows as digestion gets done, this signal disappears.

As food is absorbed by the blood, its concentration, the plasma osmolality, increases. This simulates the dehydrated condition, and forces us to drink water along with meals. If water is not available, and the food is dry, we will stop eating because receptors in the brainstem sense the increased concentration and inhibit eating. This is called dehydration anorexia.

5.3.2.4 Body weight signals

We have mechanisms to keep body weight around a set point. Long term stability of adiposity influences food intake by controlling how quickly it passes through the alimentary canal, how long nutrients remain in the blood, and how nutrients interact with the liver. After fasting, ingested calories are rapidly absorbed and stored of ingested calories and the stomich distends less, reduce eating inhibition. These changes promote overeating, hyperphagia, which restores body weight. During pregnancy, lactation, and exercising in cold temperatures, food calories are diverted to the foetus, milk or muscles, thereby making us eat more.

Body fat increases the amounts of two hormones, leptin and insulin, in the blood. There are receptors for both in the hypothalamus. The hypothalamus decides to regulate the hunger drive as levels of the hormones rise.

5.3.2.5 Obesity

Obesity is a body mass index more than 30. The body mass index is the weight in kilograms divided by the height in meters, again divided by the height in meters. Another definition is a waist circumference of more than 102 cm in men and 88 cm in women. Energy-dense tasty food and using less energy on averag cause weight gain. Bacteria in the gut, called microbiota, helps decide how much of ingested nutrients actually get absorbed. Some obese individuals have more of the bacteria of the phylum Firmucites, enabling them to break down and digest more complex carbohydrates.

5.3.3 Neural systems

The hypothalamus, a part of the limbic system common to all vertebrates, plays an important part in regulating hunger. If there is a brain region which can be considered the seat of the hunger drive, the hypothalamus is it. The brainstem, close to the spinal cord, forms a relay to the hypothalamus. The brain stem is also ancient evolutionarily, existing in all vertebrates.

5.3.3.1 Hypothalamic regulation

5.3.3.2 Brain stem regulation

Signals from taste buds, gastric stretch receptors and intestinal enzyme receptors. A rat with the brain stem disconnected from the forebrain can reflexively swallow spoonfed liquid food when its stomach is empty, but not when full. It will not swallow water when food deprived. This implies considerable control of food intake entirely within the brain stem. But it cannot modify intake based on learning, on body fat, or on time of day. These controls come from the aware brain, the cortex.

5.4 Thirst and salt appetite

Thirst can be defined as being motivated to look for and to drink water, from body fluids getting depleted. Salt appetite is the feeling to eat salty food, or drink salty liquids.

Water makes up more than half our body weight. Unlike food, the body does not store excess water. The kidneys rid the body of excess water when we urinate. Some of the body water is inside cells and some outside. The intracellular fluid is almost twice as much as the extracellular fluid. Outside cells, about a quarter of the fluid is within blood vessels, and is called the plasma. The rest surrounds cells and is called the interstitial fluid. Water moves back and forth between cells, blood vessels, and the interstices, by osmosis across the membranes.

In normal conditions, the interstitial fluid acts as a reservoir for plasma water. It diffuses into the blood through thin-walled capillaries. The pressure inside and outside the capillaries is constant, with its various components forming an equilibrium, the Starling equilibrium. This constant blood pressure is maintained by two systems. First, when we lose blood, hemorrhage, the thin-valled veins collapse redistributing blood to thicker-walled arteries which cannot collapse. Arterial blood pressure hence stays the same. Second, when blood pressure in the kidney arteries falls, the filtration rate of the kidney goes down and so less water is removed from the body as urine. This preserves plasma water and hence plasma volume.

The body preserves both the volume of water in the cells and in the blood, and also the concentration of salt. Dissolved salt density, technically osmolality, is the ratio of the amount of dissolved salt to the amount of water it is dissolved in. The body's mechanisms to keep salt density constant, osmotic homeostasis, and the volume of water constant, volume homeostasis, together drive the feeling of thirst and salt-craving. Maintaining water volume and salt density steady involves both thirst triggering water intake, and urinating which removes water and salt. The second part will be covered in the chapter on micturition.

5.4.1 Osmotic homeostasis: thirst from excess dissolved salt

When salt concentration in cells goes up we feel dehydrated and thirsty. This could be either because the amount of dissolved salt has gone up, or the amount of water has gone down. When salt gets more concerntrated in the blood, plasma osmolality rises, and water leaves cells into the plasma by osmosis, leaving them dehydrated. This is how a saline drip stimulates thirst.

Drinking behavior is triggered by 1 to 3% increases in plasma salt density above its base level. All cells in the body get dehydrated the same way, and hence brain cells which detect this, the osmoreceptors of the OVLT (Vascular Organ of the Lamina Terminalis) in the hypothalamus, have no special receptor circuits. The OVLT is connected to the SON (SupraOptic Nucleus) in turn connected to the PVN (ParaVentricular Nucleus), all in the hypothalamus. These regions secrete a hormone AVP (Arginine VasoPressin), when dehydration is detected. This hormone reduces urine, and probably stimulates the conscious feeling of thirst in the anterior cingulate cortex.

5.4.2 Volume homeostasis: thirst and salt density

When we lose blood volume, stretch receptors in the great veins entering the right atrium of the heart detect it first. When more blood is lost, arterial blood pressure falls and stretch receptors in arteries are triggered. These signals are carried by the vagus nerve to the NST (Nucleus of the Solitary Tract) in the hypothalamus. The NST is also connected to the SON and PVN, through NE signalling. Also, the kidneys then secrete the enzyme renin, which eventually forms angiotensin II (AII). AII acts on the SFO (Sub Fornical Organ) of the hypothalamus, which has no blood-brain barrier and is directly affected by plasma AII. The SFO itself uses AII to signal the SON and PVN. A branch of the pathway goes to the OVLT, where volume and concentration information get integrated.

Salt appetite is trigged by aldosterone secreted from the adrenal cortex. This hormone, in turn, is generatated when triggered by the peptide hormone ACTH and AII. ACTH is released from the pituitary, responding to CRH from the PVN. The PVN generates CRH when the arterial stretch receptors indicate blood volume has fallen, and when the kidney is filtering less (reduced glomerular filtration rate) causing blood levels of potassium salts to go up. Oxytocin, OT, released into the brain from the PVN, inibits salt intake. This hormone is released when we are dehydrated.

5.4.3 Feeling done

When and how do we decide to stop drinking or stop salt intake? Partly this is voluntary, but largely we sense we are done. Temporary satiety is produced possibly by a signal from the throat, triggered by swallowing. Longer-lasting satiety comes from cells getting rehydrated and AVP secretion being reduced. Brain cells get rehydrated the same way as other cells, and so no special signal is required to tell the brain the body is rehydrated.

We normally drink enough, based on how thirsty we feel. This matching of how much we drink to how dehydrated we are is not from any feedback signal, since most of us gulp water down. This drinking response may be learned from experience, or might be linked to the act of swallowing, or could be both combined. There might also be signals from receptors in the small intestine and the liver telling us how much water and sodium have entered the system, blocking AVP appropriately.

5.5 Food preferences in evolutionary psychology terms

Taste and its proximate analysis (the five basic tastes, the wiring of the gustatory cortex) Liking for fat and sugar. Dislikes for rotting food, bitter food Obesity as maladaptivenes.

6 Sleep: the diurnal and circadian rhythms

6.1 Oscillator hierarchy

6.2 Light training

6.3 Brain modules

6.4 Output pathways

6.4.1 Regulation of sleep/wake cycle

6.4.2 Regulation of neuroendocrine system

6.4.3 Regulation of melatonin

6.4.4 Regulation of pineal gland and other functions

6.5 sleep

6.5.1 Stages

Chapters 41 and 42 of [79], for control by the nervous system.

7 Rest

Skeletal muscles, pairing (agonistic/antagonistic), fibers. Control by cerebellum and basal ganglia. Neural control of muscle fatigue (quite a bit of the research here seems to be related to athletics and sports; need just the very basics)

8 Excretion

8.1 Micturition

9 Love and other attachments

Love has many forms: sexual, motherly, fatherly, baby love, attachment to people and places, and same-sex. Each has its own drive, and expression.

9.1 Evolutionary psychology

Evolutionary psychology posits romantic love evolved as a commitment device to maintain relational bonds between mothers and fathers and facilitate mutual investment in offspring.[58] Pair bonding arose for parental care of children. Diseases transmitted sexually, STDs, also would have contributed to forming pair bonds, since an STD, more likely with indiscriminate mating, reduces women's fertility. One theory, the interdependence theory, states people evaluate their relationships by comparing its attractiveness, the CL level, to the outcome they can get from the best available alternative, the CLalt level. People get fed up of a relationship when they think they are getting less than they deserve. The standards people use for evaluating CL and CLalt in their partner would be evolutionarily relevant cues such as the capacity for intimacy and commitment, attractiveness and general health, and social status and resources. The psychological mechanisms which get us to invest in a relationship with a partner, partner-specific investment, would be driven by the problems of provisioning (food and shelter), protection, parenting, sexual access, and commitment. Evolution has produced adaptations in us which detect and encode information about how willing and able partners are to solve these ancient problems.

9.1.1 Parenting

Natural selection favors parenting traits, since a child shares 50% of the parent's genes. Since fatherhood can be uncertain, maternal care is likely to be stronger than paternal care. There is some research and plenty of anecdotal evidence which shows mothers routinely say a newborn is more like the father. Relatives also do the same. Evolutionary theory predicts this is an adaptation to strengthen paternity certainty and get the father to invest more in the kid. Newborns seemingly do resemble the father more than the mother, which leaves the theory in limbo. The theory also predicts parents would invest more in children who are better (reproductive) bets for the future. Humans have evolved psychological mechanisms directing their care more toward their genetic offspring. Step parents and step children do not have the same parental bonds. In addition, congenitally abnormal children will be less favored by parents, their reproductive potential being less.

One begins to see why EP attracts criticism. It can be superficially wielded to justify any behavior. In its earlier incarnation, sociobiology, it had been used to block social programs. That does not make the science invalid. I will look at some valid criticisms at the end, more to show my idea depends not on whether EP is correct. For now, I will assume it is, agreeing with the academic world.

Three factors affect parenting: how genetically close the child is, how well it uses the care to improve reproductive fitness, and what other things parents could do with the invested resources. Mothers have evolved parental mechanisms absent in fathers, because they are certain the child is theirs. These include subconscious preference for babies, identifying their newborns within six hours by smell, and better recognizing facial expressions of infants. As a result, in most cultures, women spend more time on child care than men.

Since children are the vehicles for a parent's reproductive success, it is in the interests of parents to care for their children. Once again, note EP does not state parents consciously decide this, though that too is often true. Evolutionary psychology says in the past, those with genes which coded for a behavior which led to parental affection, reproduced more than others, leading to those genes spreading through the population. As a result, we, at the tail end of the long shadow of the Pleistocene, ended up with genes which, in the umbra of its shadow, had led to a module for parental care. The module still exists, and continues to be activated in the post-industrial world.

To see the difference, consider cloning. A clone carries all our genes, and a conscious decision mechanism would get a man to care more for clones than his own children. What about an EP module? That it would do the same thing since clones are genetically related 100% to us is incorrect. The other answer, that the mechanism would not kick in, since in the EEA there was no cloning, is also incorrect. The mechanism that gets a man to care more for his child works using a kin recognition system. This system is based on 1. Seeing the kid being born to a woman one has had sex with continuously, and 2. Other people telling the father the kid looks like him. For a cloned kid, the first recognition system does not kick in, but the second possibly could. The net effect is difficult to predict. That may sound a letdown, but neither EP nor observed human behavior allows many black and white conclusions.

The sidetrack aside, parents share only 50% of genetic varation from the common human baseline with kids (in general we ignore the baseline 99% commonality in these discussions). This means there will be some conflict between them as well. Parents care for themselves more than they do for their kids. Kids care for themselves more than they care for parents. Neither conclusion is new. Since both a kid and its parents share 50% of genes with the kid's siblings, it might appear the caring should be the same. However consider the problem of dividing food between children of the same size. From a mother's point of view, dividing equally across all the children is optimal, since they all share 50% of her genes. But a kid prefers getting more than the fair share, since siblings carry only 50% of its genes, while it itself has 100%. This leads to conflict of interest, or least would have in the EEA.

Specifically, parent-offspring conflict predicts: (1) parents and children will get into conflict about when the child should be weaned, (2) parents will encourage children to value siblings more than they are wont to, and (3) parents will punish sibling rivalry and reward team work.

These mechanisms can be triggered only where pair bonding is required for parenting, protection, provisioning, and sexual access. The mechanism would not be activated otherwise, since no long-time partner is required then. The ideal world should block this mechanism since it leads us to prefer some people over others, leading to sharing breaking down.

9.1.2 Sexual love

Acts of commitment are central to sexual love, and to the EP take on sexual love. From a man's side, love signals intent to stay with his mate to raise children. Love promotes commitment-enhancing behavior.

Sexual love is tied to pair bonding to provide parental care for children. Evondlutionary psychology believes long-term bonds are based on preferences by both sexes. Men would have preferred long-term bonds tied to sexual love, responding to what women looked for. It would also have helped them be sure of paternity, especially since women ovulate concealed making it impossible to identify the fertile period. Men are adapted to choose women likely to be more fertile as long-term mates. Fertility cues are either physical, such as youth, clear and smooth skin, lustrous hair, full lips or behavioral, such as a bouncy gait, animated facial expression and high energy level.

Women's long-term preferences for a sexual bond evolutionarily follow the expected pattern of older men with more resources who are healthy, high status, and sociable.

From this view, love is related to pair bonding. Love is not spontaneous. The adaptation activates responding to the input of a couple looking to be together to raise children. It signals commitment. One model, the discrete systems model, states love is enhanced by acts which facilitate relationship needs, such as taking care of one when sick.[59] This emotion is related to mate retention. Love does not get triggered in environments where pair bonds are not required for infant care. Since love is a preference for some over others, in an ideal world where everyone is to share, it is best not triggered. This means the ideal world should support infant care without using families, or even groups of people. It should be distributed across all.

9.1.3 Motherly love

Motherly love comes from inclusive fitness. A mother shares 50% of her genes with the kid, and is hence motivated to care for it. A mother also invests more in the kid from the beginning. The egg is bigger than the sperm and needs more energy input. Pregnancy and birthing are also costly in resources. Breast feeding requires the mother to eat more and spend time feeding the child. Maternal investment is more than paternal investment in parental care right at the outset. Basic economic theory states assets should never be valued by what one has invested in them, but what returns they can bring in. By this reasoning motherly love should be the same as fatherly love. Maternal care is however more crucial to an infant's welfare since it directly depended on the mother for food in the EEA (but not our societies). This would have led to motherly love as a separate adaptation.

Note that because the infant does not need the mother for food in our societies, motherly love does not go away, since the adaptation is not controlled by reasoning. However the input to the adaptive mechanism is recognition of a baby as one's own. There is some evidence mothers can recognize newborns by smell up to 6 hours after birth. But this is remembered recognition. A mother needs to smell her baby at least once after birth to be able to recognize it later. The study just shows how powerful a postpartum mother's sense and memory of smell is. In an environment where mothers will not see their newborns at all, the psychological module of motherly love cannot be triggered. There is no adaptive module which spontaneously spurs a mother to seek and care for her just born baby. No adaptive module works spontaneously.

9.1.4 Fatherly love

Platek and Thomson point out actual resemblance plays a role in a male's reactions towards children's faces, possibly modulated by a cortical module.[60] They quote several papers to show men are attracted to faces of children closely matching their own. This is supposed to be an adaptation to block cuckoldry, that is women cheating and bearing other's children.

How such a cortical mechanism would work in the ideal world depends on what it does. This is examined in ... by... Since a brain module which captures one's own image internally is unlikely, and since there were no mirrors in the past and reflections on natural surfaces are of low quality, people would have developed the ability to recognize oneself by looking at the faces of kith and kin. Mama's baby, papa's maybe.

This is another mechanism where people prefer some over others. The easiest way to make it dormant is to ensure people do not grow up with kin, so such a recognition mechanism would not be activated. No rules are required; just letting children wander free would make sure of this, since curiosity and wanderlust are also adaptations. This does mean all adults should care for children, and the social setup needs to ensure continuity of care.

9.1.5 Infant bonding

Infant bonding does not require much of an explanation. The young of most higher species requires adults to care for it. Infants would likely prefer genetic parents only if such preference can improve reproductive fitness of either the parents or the baby. Infants are not motivated to seek out genetic parents since there is no natural mechanism to identify them. They are primed to bond to caregivers.

9.1.6 Attachment to places and people

Evolutionary theory predicts we will prefer the savanna-like environment of the EEA. Since our hunter-gatherer ancestors did not have fixed dwellings and moved and camped frequently, our attachment to specific residences cannot be adaptations. More generally people would prefer landscapes with a mix of prospect features and refuge features. Prospect features such as elevated landforms offer an overall view of the landscape, easing searching for food, water and prey. Refuge features such as grouping of trees allow one to stay concealed when one has to feel secure. One other theory adds mystery and complexity to the list, keyed off the adaptive function of curiosity, which predisposes us to seek new information about the environment to master it. This trait is neutral, since it does not interfere with others.

Attachment to people comes under the reciprocal altruism umbrella. Reciprocal altruism is based on costs and benefits. People like to remain attached to those they have done a favor for, to ensure it gets returned. If the costs of a favor become zero, the mechanism becomes deactivated. People can do favors even with no return benefits. The ideal world should hence ensure all wants are met free, so time helping others does not affect survival or reproduction.

9.1.7 Same sex love

Some homosexuality, especially in ancient cultures, has come from control of sex. Prisons to monasteries show this[61]. Supporting data comes from Kinsey, among others. Ancient Greece had man-boy love, pederasty, almost systemic. However, this cannot be considered a true gay drive. As Voltaire remarked : “A young boy will often, by the freshness of his complexion, by the intensity of his coloration and by the sweetness of his eyes, resemble a beautiful girl for the space of two or three years; if he is loved, it is because nature is misunderstood; on becoming attaching to the one who has these beauties, one renders homage to sex, and when age has made this resemblance vanish, the errors cease."[62] But homosexuality cannot all be based on such artificial contexts, since it has been around from our earliest civilizations. Some of it can be genetic.

If a homosexual gene exists, those carrying it will reproduce less and the gene will die out. Biologists have thought up two ways such a gene can remain. One is kinship selection, and the second a case where the gay gene improves reproductive ability as well. These mechanisms explain how a gay gene could have arisen and stayed in the population. Note the actual presence of the gene is far from proven; we assume it exists only to cover all possibilities.

9.1.7.1 Kinship selection

For gayness, kinship selection is expected to work by a gay person being able to provide more support and attend to more family chores than a heterosexual male. The gay guy's contributions would lead to the extended family unit surviving and reproducing better. The gay uncle theory is not widely accepted since the reproductive advantage to the extended family is slight, and probably not enough to overcome the major disadvantage of the uncle not having any kids.

Kinship selection theory depends on an environment where an individual associates with kith and kin, and contributes to an extended family of biological relatives. It implies unequal sharing. To deactivate it, having children not grow up with blood relatives is necessary and sufficient.

In the ideal world kinship selection can be made to not operate by having individuals grow up away from biological relatives. Only individual reproductive fitness will determine which genes are more likely to be passed on. If the gay gene has stayed with us because of kinship selection, in the ideal world, it can be made to vanish. This is not based on the correctness of kinship selection as applied to gayness. It is based on kinship selection itself vanishing in the ideal world. There are other equivalent theories, such as gayness being selected for in dolphins, since it reduces violence and killing between males. These theories cannot apply to the social setup of any ideal world.

9.1.7.2 The overloaded gay gene

The second theory for a gay gene is one designed to allow its existence. To understand what drives the theory, one needs to look at gene inheriting in more detail.

A gay gene requires complicated theories, separate for the gay and lesbian version. A gay gene could exist on the autosomal chromosomes. This means one could have carriers who are not gay but pass on the allele. But over a period of time, the allele would vanish since gays will not reproduce and pass on their genes. For the gene to stay, carriers have to reproduce more than others to make up for the difference. An autosomal allele which does two exact opposite things when dominated and when dominating is a stretch.

That leaves the sex chromosomes. A standard gay gene on a Y chromosome would immediately vanish since gays would not naturally reproduce. For a man to inherit a gay gene, it has to be a carrier gene on the mother's side, that is a gene which has no effect on the sex drive of women, but causes gayness in men, by interacting with the Y chromosome. The likely chromosome would be the mother's X chromosome, since this is what pairs with the Y chromosome which makes one male, at least when forming sperm.

Such a gene can be passed on from a carrier mother to produce gay sons, and carrier daughters. However, once we look at the generation of granddaughters, the original problem pops up again. Since gay sons do not reproduce, and only carrier daughters do, such a carrier mother would have fewer grandkids than non-carrier mothers. Her carrier gene would eventually be swamped out by the non-carrier version.

The only way to get around this is to postulate such a gene improves reproductive fitness in a carrier mother. In other words, the carrier X gene causes the mother to reproduce more, and produce more of both gay sons and carrier daughters. Though the gay sons may not reproduce, the carrier daughters, already outnumbering non-carrier daughters of other mothers, would reproduce even more to make up for the slack.

One can be sure numerous unpublished attempts have been made to locate such a gene by surveys and studies. One paper has been published on such a gene in a family in a corner of Italy (Lemmola and Ciani, *New Evidence of Genetic Factors Influencing Sexual Orientation in Men: Female Fecundity Increase in the Maternal Line* in *Archives of Sex Behavior*). The results have been strongly challenged on grounds the so-called reproductive advantage seems to have extended to those not carrying the gene as well (non-carrier mothers). In modern-day Italy, it is hard to believe the number of kids a couple has depends on genes, and not their social, cultural and financial position. Other previous studies failed to find a preponderance of gay relatives in the maternal line of homosexual men (McKnight and Malcom, *Is male homosexuality maternally linked?*, in *Psychology, Evolution & Gender*).

This gay gene theory has three serious flaws:

1. Ciani does not use precise criteria such as the ratio of the number of unprotected matings to the number of conceptions, or medical indicators of infertility, to assess fertility. He looks just at the number of children a couple has. There is nary a culture where this proves fertility. Statistically religion, economic standing, educational standing, and some degree of free will dictate how many children a couple has. The role of genes has receded to where it is only marginal.
2. The fertility increase in carrier women has to be within a tight limit. Any higher, and carrier women will outreproduce and swamp non carriers. The proportion of gay men will correspondingly increase. Any lower, and carrier women will consistently decrease in proportion and die out. Ciani's math glosses over the problem. In general, evolutionists consider only species-typical traits to be produced by some reproductive advantage. Gayness is not typical of our species, and a theory which says it stays in the population because of a reproductive advantage to the opposite sex is forced to assume an artificial equilibrium between the fertility increase in carrier women and the probability of their daughters being carriers. A trait that has been limited to a low percentage of the population, and has stayed that way for recorded history, cannot be naturally explained by a reproductive advantage theory.
3. The theory does not extend to lesbianism, since lesbianism

> reduces a woman's fertility to zero, independent of all other genes. To explain lesbianism, one has to postulate another gene in the autosomal or x chromosomes, which makes males more fertile, but women lesbian. The complex and ad hoc nature of the theories make them highly suspect.

9.1.7.3 Gayness as a continuum

These problems with the existence of a gay gene are not problems with specific theories. They are fundamentally based on gays reproducing less.

Kinsey believed gayness was not an all-or-nothing trait. He considered men to be bisexual to varying degrees. Straight heterosexuals are attracted only to women, and straight gays only to men. Many are in-between with varying degrees of attraction, with their gayness varying with time and circumstances. In other words, bisexuality can be seen as an orientation with the degree determined by both a set of genes and the environment. Kinsey graded people on a six point scale, from purely heterosexual to purely homosexual, but the number six was chosen as a convenience, not from any statistical analysis. [Graph here]

This makes bisexuality a genetic disposition similar to the genetic disposition for behavior such as aggression. This makes for a more solid footing to the analysis. At least a part of homosexuality can be viewed as genes producing a subtrait, which the prenatal environment and the formative years modify, to create a trait hardwired in the adult brain. One immediately questions why the tail of the curve does not get chopped off, since the gays there do not reproduce. Because those to the left end reproduce more, the curve should shift to the left more and more after every generation, ending with fewer and fewer gays, and men partially attracted to men.

The simplest explanation is, until recently, gay men have been forced to lead a "normal" life, "married with many kids." All men biologically capable of reproducing have, with reproduction controlled more by culture and economics, than the male sex drive. In the ideal world, any innate bisexual tendency can be made to vanish having reproductive selection work in its simplest, most basic form. This is not an outcome gays have to argue against, since this has nothing to do with how to treat existing gays.

9.2 Behavioral genetics

How sexual attraction and attachment varies in people is immaterial to us. Incidentally, the first varies more for women than men. Motherly, fatherly and infant bonding cannot have a purely genetic basis, since recognizing a baby or a parent is not possible except via learning.

9.2.1 Same sex love

Apart from any innate genetic contribution, environmental factors are also thought to create same-sex orientation. The natal environment, the womb, is thought to play a role with chemical influences triggered by earlier births of sons. The early social environment could also be relevant.

For gay sex, anatomically, only three forms are possible: mutual masturbation, the oral way and sodomy. Mutual masturbation does not satisfy the male urge. The general idea is to rub or squeeze the penis against a soft part of the other guy's body. The oral version is less pleasurable than the real one. Teeth get in the way and even otherwise the mouth cavity does not adjust its size to a thickening penis. Even when the partner purses lips or pulls in cheeks whilst sucking, oral sex is not as enjoyable as thrusting into an elastic vagina, that fits right. Sodomy tortures the person at the receiving end since it leads to torn skin and bleeding. The pain would mostly outweigh the pleasure of stroking the prostate gland. Thrusting between buttocks with no penetration and other variants do not work as well since men have leaner and harder hip and buttock. Women are softer than men, with more fat and less muscle, making sex with them pleasurable. Gay sex is therefore inferior. Lesbian coupling is mutual masturbation. Since gays have less sex pleasure than other men, the ideal world should work to make the chemical influence on the fetus, if any, go away. This does not mean shunning existing gays or trying to 'cure' them.

There are people natively transgender. Rarely men are born with vaginas. But then there are handicapped people born mute, deaf, blind or paralyzed. Biologically-sexually defective persons belong to the same class as the other handicapped. We do, can, and should build societies assuming such deviations from our standard biology are to be treated as special cases.

9.3 Neuroscience

Love is best understood by looking at the biology of attachment. Biologists consider love a form of pair bonding, that is preferring one person over another. This definition applies to the asexual kind as well. Sexual love is tied in with the drive, something already covered. The hormonal basis of attachment to both individuals and social networks best describes love biologically.

This too is a field in flux, with no seminal works. Published summaries of existing theories are the best place to start. One such is C. Sue Carter's *Neuroendocrine Perspectives on Social Attachment and Love* published in *Psychoneuroendocrinology*. We will also survey some individual papers on the subject in the last decade, not covered by the summary. Most of the conclusions are tentative, but accurately indicate how biologists think of this emotion, as opposed to the more imprecise wording in popular science books, with a different emphasis.

Carter looks at when we get attached or fall in love. Birthing is an experience that leads to bonding both on the mother's and the baby's side. So is lactation, that is breast feeding. Sex, stress and novel situations are other likely triggers. The hormonal basis for attachment is thought to be similar for all cases, though the weight associated with each hormone would differ for each case. The hormones involved are OT, AVP, and the catecholamines (stress hormones, mainly DA, NE and EP). Table 1.1 on page 45 lists the hormones in the references, along with their short names.

9.3.1 Sexual love

Popular science calls OT the love hormone (*The Agile Gene*, 2003, Matt Ridley, p. 48). Its primary function is to help muscles contract, particularly during labor. Vaginal stimulation releases OT in rats. A monogamous species of rats, the prairie voles, shows increased social bonding when injected OT reaches the brain. However these results are mostly for female voles. For males, the analogous hormone is AVP. There are cells in the brain called OT receptors which absorb circulating OT. The gene which codes for OT receptors is different in the monogamous prairie vole from its close cousin of the same genus, the non-monogamous montane vole. Specifically, the promoter element, a section close to the actual gene, which controls how often the gene gets turned on, is longer.

What makes the data ambiguous is that prairie voles are not sexually monogamous, they just pair to raise baby mice. Prairie voles in Kansas do not show even that behavior fully, unlike the ones in Illinois.[63] Clearly the gene codes for a particular disposition, not a final, fixed trait. Humans have a different kind of a promoter, a shorter one, in the same regions. Rats copulate only when the female is in estrus, and male rats do not feel sexually attracted to other females. This basic difference in the sex drive makes extrapolating sexual love from rats problematic. What the gene does in rats is also influenced by early experiences and environmental demands.[64]

The same hormone, OT, works in general attachments. Sexual love is not separate from general stress-reducing attachment. It is tied to social bonding, covered later. The sex act feeds and strengthens it through the pleasure reward circuitry.

9.3.2 Motherly love

For motherly love, in Carter, p. 792:

> Both maternal responses and lactation are facilitated by the hormonal events of pregnancy and birth, which include prolonged exposure to comparatively high levels of progesterone and estrogen, a subsequent dramatic prepartum decline in progesterone, and increases in oxytocin and prolactin . . . However, hypotheses regarding hormonal causes of parental behavior are complicated by apparently normal parental behavior being observed in virgin females even after removal of the ovary and uterus, as well as in males of many species.

The hormones are not coding for an attachment to biological offspring. They facilitate an attachment to the young, biologically related or otherwise, which exists even otherwise. Parental behavior is not an attachment of mother or father to son or daughter, it is a general attachment of the adult to an infant of the same species (conspecifics). Hormones may assist this behavioral mood. In a previous section on the same page, Carter states: “Mammalian parental behavior is usually measured by approach and positive caregiving behaviors directed by adult animals to young conspecifics. It has been proposed maternal behavior is facilitated when the tendency to approach infants is stronger than the tendency to avoid infants. Hormones associated with birth, or other factors . . . are believed to inhibit this fear-based system." Hormones may help adults get over an aversion to infants, and that way help care for them better. This is not a solid fact, but the entire discussion centers on infants of the same species, not biological offspring.

9.3.3 Fatherly love

The hormonal basis of fatherly love is irrelevant because of paternity uncertainty. The recognition mechanism, a more important influence for a father than a mother, is learned.

9.3.4 Infant bonding to mother

Imprinting is the technical word for infants getting attached to an adult, mostly ones they see at a specific stage in their development. This is seen in some species but not humans. Babies do not recognize their mothers or their voices until sometime into infancy. Any nursing woman can suckle a baby to develop the same bond the genetic mother can. An infant's attachment is not to the genetic mother, but to behavior, from an adult human, which provides it warmth, comfort and milk. Again, this bonding may be facilitated by OT. Nothing in the hormone literature suggests the bonding has to be to specific individuals or sets of individuals. There is no reason why hormone release should be less if an infant is brought up by a group of people, instead of just two parents. As we will see in the next subsection, the bonding will then be more diffuse and less intense. Whether that is good or bad, endocrinology cannot answer.

Motherly love has long been considered special because of the mother's non-genetic biological ties to the baby. Specifically, carrying the baby in her womb, and breast-feeding after birth.

There is research, now almost two decades old, which proves prenatal learning. Newborns prefer human voices to other sounds, female voices to male ones, and the mother's voice to others. Specifically, the voice as heard in the womb (a muffled version of the real one) is what newborns are attracted to. A newborn also tries to inch toward a breast scented with the amniotic fluid of its mother but not to an unscented breast.

The research defines a preference as moving toward a stimulus. Most would consider this recognition. That a newborn recognizes the voice and scent of its womb is likely. But they lose this ability within the first 2 or 3 days outside the womb. Such born-with preferences are stronger in most other mammals, since they spend a longer proportion of their early developmental stage inside the womb. Human babies are born developmentally immature, with very weak memories from the womb. What little is there is lost fast. There is no reason to boost and buttress such a weak preference, when losing it is known to have no consequence.

Breastfeeding was once considered a true bonding element. Harry Harlow, in a well-known article, *The Nature of Love*, published in *American Psychologist* showed a rhesus monkey's maternal attachment was to physical contact more than the milk. Harlow's dummy mother, which the infants considered equal to a natural mother, was just a round cloth figure similar to a snowman. His research proved rhesus infants get attached to a soft, warm, tender, reliable body. Something regular contact with adults, not just the mother, would provide. To quote:

> As far as we can observe, the infant monkey's affection for the real mother is strong, but no stronger than that of the experimental monkey for the surrogate cloth mother, and the security that the infant gains from the presence of the real mother is no greater than the security it gains from a cloth surrogate . . . This baby had contact with the blank-faced [cloth] mother for 180 days and was then placed with two cloth mothers, one motionless and one rocking, both being endowed with painted, ornamented faces. To our surprise, the animal would compulsively rotate both faces 180 degrees so that it viewed only a round, smooth face and never the painted, ornamented face.

The monkey baby was innately drawn to a warm, soft, solid figure with no holes, but not to any particular type of face. Later research would show there were indeed differences in how babies were attracted to a real mother and an inanimate one in that the first group developed more separation anxiety. Since an inanimate mother does not simulate maternal behavior, this is to be expected. The core point Harlow destroyed was the belief biologically being able to feed one's baby directly led to a special affinity on the kid's part. In his dry words: "These data make it obvious that contact comfort is a variable of overwhelming importance in the development of affectional response, whereas lactation is a variable of negligible importance." As we will see later, behavioral scientists are rarely this definitive.

Harlow concluded:

> It is cheering in view of this [women moving to the workforce] trend to realize that the American male is physically endowed with all the really essential equipment to compete with the American female on equal terms in one essential activity; the rearing of infants.

Feminists would make the same point a few decades later. A rhesus infant's attachment is to an adult who cares for it, plays with it, and holds it. Humans are not monkeys, but the differences in general are in the direction of less instinctual hardwiring and more capacity to learn, for traits which have always been taught. In science, Harlow's experiments struck a mortal blow to the idea motherly love was sacred; any or many adults, conspecifics, would do. Feminists used it to destroy the myth of the mother in Western culture. Once again, I agree with them.

Human babies are born less mature than most other primates. They have to be, since increased skull size from higher intelligence makes delivery impossible at a more mature stage. This means humans are exposed to a longer developmental learning phase, starting at an earlier stage of life. It also means it is harder to care for newborns than in other primates. The maternal care model of those animals does not work for us. From a pure task difficulty point of view, group upbringing is logical.

9.3.5 Infant bonding to caregiver

Though Harlow's studies showed an infant is not biologically attached to the genetic mother, it does not rule out the need to be attached to a specific adult, instead of a group. The British psychiatrist, John Bowlby, formulated an influential theory of attachment which stated, with some proof, human infants become attached to adults who are sensitive and responsive in socially interacting with the infant, and who consistently provide care for some time from 6 months to two years of age. While the general statement seems obvious, the details are debated.

Endocrinology, as mentioned in the next section, shows how attachments would be weaker in a world with little stress. This includes an infant's bondings. Both attachments and stranger wariness would vanish. Psychologists and psychiatrists have proved such weakened attachments and trusting strangers are often a negative in our societies. The support mechanism of attachments is a must in our worlds. Any ideal world would have no need for such crutches since there should be few stressful situations to deal with, either internal or external.

9.3.6 Attachment to places and people

Carter's working model for the role of steroids and neuropeptides in social attachment (p. 802) is an interesting place to start.

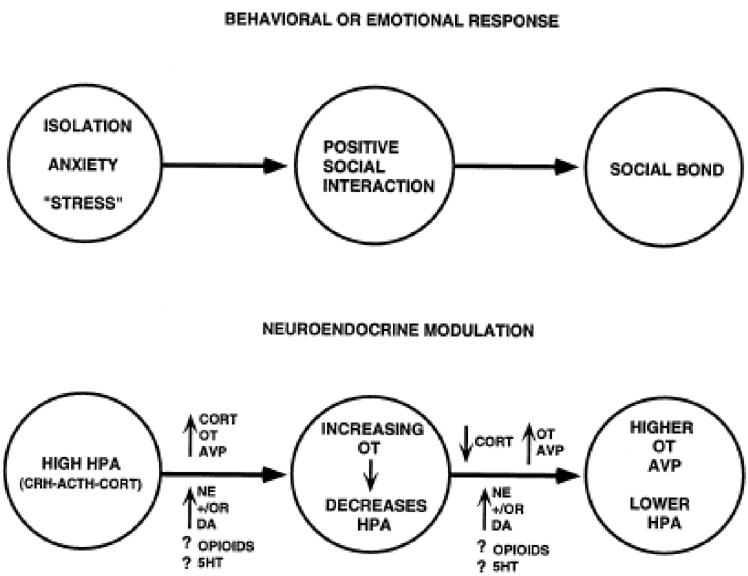


Figure 9.1: Carter's model of hormones in social attachment

In figure 9.1 on the previous page, HPA stands for the Hypothalamus Pituitary Adrenal axis, which describes the mechanism of adrenaline release under stress. The Hypothalamus, a region of the brain, signals the Pituitary gland, located next to the brain, which in turn sends a neural message to the adrenal gland in the kidney. This gland releases adrenaline into the blood. An up arrow indicates rising levels of the labeled hormones, and a down arrow a falling level. At the left, the figure shows isolation, anxiety or stress, causing high HPA activity, and releasing a bunch of hormones. A positive social interaction releases OT which reduces the stress hormones. The memory of this soothing effect leads to a social bond. CORT is corticosterone, ACTH, adrenocorticotropic hormone, and CRH corticotropin-releasing hormone, all released by stress. Finally 5HT is serotonin, a hormone that inhibits the working of DA.

Carter, p. 802:

> Stressful experiences (such as pregnancy and parturition), anxiety, neophobia and isolation often precede the formation of social attachments . . . These circumstances may increase social drive or motivation and subsequent social interactions. Positive social interactions in turn could be rewarding and in species or individuals that possess the capacity to form attachment, positive social bonds would follow. Both positive social interactions and social bonds could function to provide a sense of safety and reduce anxiety or stress.

Later, p. 808: "A recent review of the role of stress in human attachment concludes that stressors trigger the need for proximity and attachment behaviors, and surmises that some degree of strong, yet manageable stress may be necessary for very strong bonds to form."

In other words people form attachments, including love, to support themselves against stress and anxiety. Hormones help them remember this behavior and automatically repeat it. The hormone OT does not code for attachment per se, it works by reducing the impact of stress hormones, and alleviating stress, with social attachments. In a society where stress is absent, preferential attachments will also cease. People will still be attached to other humans, conspecifics, at least from rational thought and self interest. But there will be little in the way of a bond to a specific set of people or places. That is what the ideal world should aim for.

That love soothes by distracting us from the difficulties of the real world is not a new discovery. But the description of hormonal changes associated with this is new. There is no hormone which drives us toward love overriding everything else, OT drives us toward love and other attachments by mitigating stress. In our societies, the effect of OT will be felt far more than in the ideal world.

Finally, " . . . developmental hormonal experiences can alter adult gene expression for both oxytocin and vasopressin receptors." We can be brought up to feel less love or more love to people. That the second is better is an axiom in the West, but not necessarily elsewhere. Many religions consider fewer attachments better. In the ideal world attachment will be nil, since their role in current societies, of providing mental support, will become obsolete.

What else would then be lost? Great works of art and literature. The Trojan war and the songs of Homer. Antony falling on his sword and the sonnets of Shaw and Shakespeare. The unloved pretty prophetess of doom, Cassandra. Fanciful fiction and fairy tales. The pathos and the poetry of love.

Great works have long been the ones which distract us the best. In our worlds they fill a need. They rise from love for the same reason love rises from stress. Art and literature may exist in the ideal world, but they will not draw on love and its results. What measurably improves our quality of life—math, science and technology —has never drawn on emotions.

9.3.7 Same sex love

In 1991, Simon Levay noted a brain region, INAH3(Interstitial Nuclei of the Anterior Hypothalamus) was smaller in presumed homosexual men than heterosexual men.[65] The region was also smaller in women.

The results are not considered verified after almost 20 years.[66] Sufficient number of studies have not been done to replicate it either. The brain tissue was obtained from autopsies; those of healthy adults rarely end up with an autopsy. All of the 19 gay men had died of AIDS. Of the hetero men, only 6 of 16 had. A bigger issue was the differences were statistical. There were hetero men with smaller INAH3 than gay men. Finally, and importantly for us, the authors note that the INAH3 difference could be either cause or consequence. And it does not prove gayness to be genetic, since development of this area can be influenced in the womb by chemicals. Whether it can be modified by experiences during childhood or later is unknown. Behavior can affect regional neuronal density. Rat spinal ganglions, for example, are changed by frequent sexual intercourse, as shown by Marc Breedlove in a letter to Nature titled "Sex on the brain." Despite the title (and the author's last name), the correspondence is serious, with University of California, Berkeley's reputation to back it.[67]

There are similar unconfirmed reports from tiny samples on male to female transsexuals having a smaller bed nucleus of the stria terminalis and INAH3, and brain activation pattern differences in gays, lesbians, male to female transsexuals, and heterosexuals.[68] All they show, even that weakly, is the minds of those who mate with men and those who mate with women differ. There is significant bias present as well—by March 1994, Levay had left Salk to found a Gay & Lesbian Education institute. Agendas can bias statistical results on small samples. The only reason I covered Levay's paper is because, coming from a prominent neuroscientist, it attracted public attention. New York Times covered it under the catchy title: "Zone of brain linked to Men's sexual orientation." The tortured grammar of the the first sentence shows the haste: "The brains of homosexual men [are structurally different], a scientist says he has found."[69]

Most research into the neuroanatomical basis of homosexuality and transsexuality has similar issues. All preferences have a biological substrate, in the sense all of what we are is represented biologically. Those who have learned to roller skate should have a brain which differs from those who have not. Gays are guaranteed to have a brain which differs from heterosexuals in some way. As Dr. John Mooney of Johns Hopkins puts it in the NY Times article: "It's axiomatic that sexual orientation is going to be represented in the brain somewhere." How that difference develops is the more interesting part. Serious neuroscience considers this an unsolved problem.

10 Our behavioral traits

Human behavior cannot occur without two ingredients: (1) evolved adaptations and (2) environmental input that triggers the development and activation of these adaptations.
Evolutionary Psychology, 2005

The nature versus nurture debate is a nuanced one. The popular media often presents genetic findings as a win for the nature group. The history of behavioral science is often thought of as see-sawing from one side to the other. With nature on the rise right now. That way blocking all philosophies and social theories which aim to change societies, that is the nurture part.

The many published papers and the few standard texts on behavioral genetics present a more accurate and detailed picture. All behavioral traits, without exception, are considered to be influenced by both genes and the environment. The degree to which each contributes is analyzed mathematically. The mechanism by which each contributes is guessed at. To see how these findings relate to my vision, I need to dig into the details. Specifically, the current ideas of the interaction between genes and the environment need to be looked at, in depth, to see how changing the environment alone would modify the behavior.

There is a second subtle argument against any ideal world, involving free will. Many people assume at least part of our problems are of our own making, resulting from decisions we make or attitudes we choose to develop or retain. At least to some degree, we may be capable of thinking or imagining ourselves into being cheery. Case studies help address this objection, by highlighting the nature of events which form negative feelings.

Note a large number of behavioral traits are not relevant to us. Selfishness is an example. Where resources are sufficient, a selfish need to satisfy one's wants does not get in the way of an ideal society. To ignore selfishness, it is enough to identify needs and prove resources for those needs are sufficient. Personality traits such as shyness, introversion and timidity also matter not. An ideal world which cannot accommodate the shy and the timid is not an ideal world for all. The traits which get in the way of any ideal world are competitiveness, possessiveness, jealousy, social and dominance hierarchies, sadism, hate, and violent or delusory mental illness. The last has been the best studied, and the principles psychiatric genetics follow apply generically to all traits. I will hence look at the behavioral disorders first.

10.1 Mental illness

Mental illness can be classified broadly into schizophrenia, affective disorders such as depression and bipolar disorder, and personality disorders. Schizophrenia is the best studied, is highly destructive, and best represents the entire class.

10.1.1 Behavioral genetics

Behavioral genetics looks at the heritability of mental diseases.

10.1.1.1 Schizophrenia

The inheritability of schizophrenia is well described in *Schizophrenia and Genetics, A Twin Study Vantage Point* by James Shields and one of the foremost researchers in the field, Irving I. Gottesman. The book describes the statistics gleaned from schizophrenic patients with twins, from the records maintained at the Maudsley Hospital in London during the postwar period 1948-64.

Gottesman analyzed and summarized the case histories of 24 identical and 33 fraternal twins, with at least one member of each being schizophrenic. He also collected extensive statistics on concordance rates, that is rates at which schizophrenia in one twin was seen with schizophrenia in the other, and tried to account for environmental influences by looking at the case history and directly interviewing the twins and following up on their progress later. He explains his basic perspective in the Prologue, p. 6:

> The bulk of gene-determined human variability arises from the simultaneous occurrence of many small discontinuities, polygenic effects, which, when put together and smoothed by environmental effects, are not individually detectable and result in (bell-shaped) continuous variation in a trait . . . Polygenic systems contain certain features that contrast with single-gene substitution. The traits are especially sensitive to internal and external environmental influences, thus reducing the correlation between genotype and phenotype.

A genotype is a person's genome. A Mendelian trait is the result of a single gene passed on through the generations following some laws first discovered by Gregor Mendel in the mid 1800s. A Mendelian disorder is one caused by a single gene (more precisely a single locus, that is the two paired genes on the two chromosomes). A polygenic disorder is one influenced by two or more genes. Finally, a phenotype is the actual observed behavior or trait, in our case the symptoms of schizophrenia.

Gottesman's perspective, as quoted above, is he believes every human behavioral trait varies affected by many genes and the environment. The net result is that the variation is distributed in a bell-shaped curve, the normal curve, with many people in the middle and the numbers tailing off as one moves away from the center to the left or the right. See figure 10.1 on the following page for an example normal distribution. As an example, take extroversion. Most people are average in their outgoing nature, and the numbers continuously drop as we move to the right (more and more extroverted) and to the left (more and more introverted). As we will see, behavioral geneticists hold the same point of view almost 40 years later.

The statistics in p. 218 of Gottesman show almost 50% concordance rate for schizophrenia. Erik Essen-Möller, one of the founding fathers of psychiatric genetics, judged each MZ twin separately on a decreasing severity scale of 1 to 5, and N for normal, and found no discordant pairs where one twin was a 1 and the other was an N. Most other combinations were present.

Gottesman believed the best model which explains his data was the diathesis-stress model. This model assumes we are born with predispositions or vulnerabilities (diatheses) which when exposed to stress or exploitation, worsen the mental state. Gottesman considered schizophrenia as the outcome of a genetically determined developmental predisposition. He based this on the concordance rate being 50% for MZ twins. A purely genetic cause, etiology, would have led to the full concordance rate seen in Mendelian disorders. Any concordance rate below 100% implies either the environment is involved or some schizophrenias are genetic and others not. If, of two people with the exact same set of genes, only one develops a disease or trait and the other does not, clearly the circumstances have contributed. The environment might be prenatal,

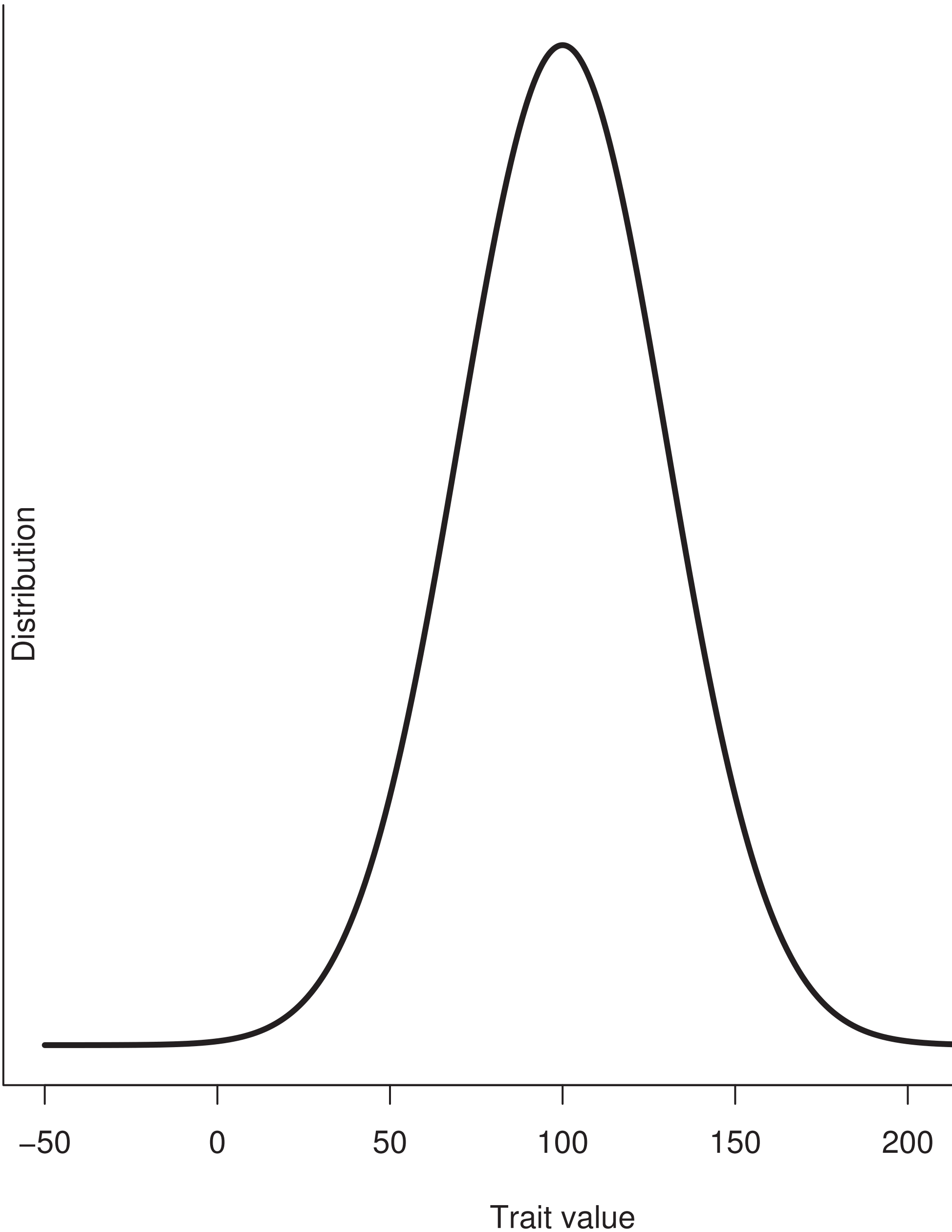


Figure 10.1: Normal or Gaussian distribution of a trait

health-related (nutrition, disease or injury), social or related to a person's free will (chance elements).

A concordance rate of 50% could imply half of the schizophrenias seen in MZ twins is genetic and the other half environmental. Gottesman rules this out, in p. 43, using earlier research by Fischer. Who found the risk of schizophrenia for the children of normal MZ co-twins of schizophrenic patients was roughly the same as the risk for children of schizophrenics generally, and the risk for MZ schizophrenics. The various schizophrenias did not differ much in their genetic influence. Schizophrenias were not divided into a genetic version and environmental version. That left the other explanation, schizophrenia came from a genetic disposition, fanned by the environment.

This leaves the question of how the pull of the genes would turn out in the environment of the ideal world. What environments worsen it, and which ones leave it dormant? Here we need Gottesman's detailed conclusions.

Schizophrenia strikes in a narrow age range, the mid teens and the early 20s. Nobody is born schizophrenic. The changes over time making a predisposed schizophrenic go mad, are either environmental or growth related. Nutrition could be an influence. Experiences of adolescence and the teens almost certainly matter. Innate growth-related changes cannot cause discordant MZ pairs, since they share all innate genes. Illness could be meaningful.

In the ideal world, the stress of adolescence and the teens has to be far less. This implies free sex, no formal schooling and no discipline of set hours. To make these assertions more concrete, we need to examine the nature of the environment which causes one twin to go over the edge in various cases. Specifically the role of illness, injury and free will. The first two can be directly checked by summarizing statistics. But what if some twins go schizophrenic because of their prior disposition and their actions driven by free will? This would be a major objection to any ideal world, since free will, as I will show later, is not tractable analytically. The case histories of the discordant MZ pairs in Gottesman prove valuable in evaluating the environmental etiology of schizophrenia.

Case histories form a major part of the book: 138 tragic, terror-filled, pain-wracked pages. Of the 24 MZ pairs, numbers 3, 4, 5, 8, 9, 11, 12, 14, 16, 20 and 23 are discordant. Gottesman calls the schizophrenic twin 'A' and the other 'B'.

MZ 3, male twins. The schizophrenic twin was a Japanese prisoner of war in Indochina, and Gottesman says: "The difference between the twins must be accounted for by experiences undergone by A and not by B, acting upon a schizotypic genotype." The non-schizophrenic twin, B is described as slight, shabby, diffident, shy, monosyllabic, obstinate, occasional sweet smile, bullied by wife, and responding to worries by getting touchy. The schizotypic genotype should be able to flower in an ideal world.

MZ 4, both female, born to a mother who died in a mental hospital, with a maternal grandfather who died at 50 in a mental hospital. A had a short mental episode and was hospitalized, deluded and hallucinating, for 6 weeks in the mid 30s. Gottesman does not believe schizophrenia is the right diagnosis. But for us that is not relevant. A lacked self-reliance as a child, complying with her mother who feared A would not live to be 21, even after she had turned 18. B was closer to her father. A broke down shortly after her mother died in a mental hospital.

MZ 5, both female. A, the patient, had a tonsillectomy (removal of the tonsils) at age 16, with botched-up anesthesia. She woke up in the middle of the operation, under pain and shock, and later had screaming attacks where she thought men in white coats were coming at her with knives. Went downhill, addicted to sleeping pills, obtained by forgery, stealing and homosexual prostitution. Ended up in a mental hospital at age 44. Gottesman considers this to be a case where schizophrenia was mostly environmental in nature.

MZ 8, males. A loved a girl who did not love him, and ended up hallucinating (voice of the girl talking to him) at age 29. B had trouble concealing anxiety and failed a cadetship test for the air force. Per Gottesman, "A underwent a gross ego insult, the rejection of his love with its implied doubt of his masculinity, that served to release a schizophrenic diathesis."

MZ 9, females, with A the patient an alcoholic. Gottesman considers this to be the cause, but then A's father was also an alcoholic, and she was more attached to him than her twin sister was.

MZ 12, male. Conclusion: "In the absence of more detailed information, one can suppose that discordance with respect to this condition was associated with the quieter, more submissive twin's having been overtaken in athletic prowess by his brother, by his being severely criticized on this account by their rigid father, and by the sudden death of the housemaster [of boarding school] . . . ".

MZ 14, male. Again, the conclusion: "Both twins have been exposed to disruptive moves as children and to a series of unhealthy psychic events, primarily an intrusive mother and a harsh rejecting stepfather. A, additionally, suffered the forceps delivery and was 1¼ pounds lighter at birth than B."

MZ 16, a male pair. Mother, chronic neurotic, highly strung, overprotected the proband, the patient A, who was tied to her apron strings as a boy.

MZ 20, a female pair. The patient A was later reclassified from schizophrenic to depressed. She had been diagnosed with thyrotoxicosis, which causes extra thyroid hormone production, which in turn increases cell metabolism throughout the body. Also had a hysterectomy (removal of the uterus) at age 41 because of abnormally heavy menstruation, menorrhagia. Later, at the same age, had her thyroid removed. B also had thyroid trouble and radioactive iodine treatment to inhibit thyroid activity.

MZ 23, both men. The proband A was forced to marry a woman he had known for 5 years, but left after 3 months for another girl. Joined a cult believing in psychic alignment and thought radiation. The brother B married at 19 and deserted pregnant wife. At 22, became follower of the same cult, and lived with A's wife while A was ill to open her as practiced in the cult. Gottesman lumps them in the same category. But B was not deluded or hallucinating, even though he did think irrationally.

This tour of the discordant MZ pairs highlights the environmental differences which triggered the illness in one pair but not the other. With one exception, they are related to the family, social, educational and vocational environment. The exception is MZ 20 who had thyroid problems.

An ideal world hence needs a different set of family, social, educational and vocational systems. One with no war, children brought up with no parental ties, no love related to mating, no athletic tournaments, no step parenting, and no forced marriages. At the very least.

There have been more studies on the genetics of schizophrenia. In the book by Plomin and others, Owen and O'Donovan summarize the results in p. 466. The concordance rate measured in MZ twins has essentially stayed the same. They conclude: "Although it is clear that there is a genetic contribution to schizophrenia, the frequency with which MZ twins can be discordant for schizophrenia strongly suggests that what is inherited is not the certainty of disease accompanying a particular genotype but rather a predisposition or liability to develop the disorder." It is not a vulnerable person's choices which leave him or her with dark days and bright nights—in all the cases examined outside forces were responsible.

This conclusion is important because other human behavioral traits behave the same. Gottesman, as the first line of his chapter on genetic theorizing and schizophrenia: "A basic postulate of contemporary human genetics is that all of a person's characteristics are the result of interaction between his genotype and his environment." Disposition, not destiny, is inherited.

10.1.1.2 Mood disorders

Mood disorders, technically affective disorders, constitute the common mental disorders. Of these, clinical depression and bipolar depression are severe, and fairly representative. Kalidindi and McGuffin explore the genetics of these in a 21 page article in Plomin's book. MZ concordance for them ranged from 20% to over 50% in various studies (p. 483). As before, this implies one of two things —either some depressions have their genesis in genes and some in the environment, or depression is caused by the genes and environment combined. This has been resolved in a way similar to schizophrenia. From p. 484:

> The incomplete concordance in MZ twins indicates that nongenetic factors play a role in the liability to bipolar disorder. Thus, discordant MZ pairs might arise because the affected proband has a nongenetic type of disorder. Gottesman and Bertelsen (1989) tested this by studying the offspring of discordant bipolar twins. They found that in the offspring of the unaffected MZ twins, the risk of bipolar disorder was increased to the same degree as in the offspring of the affected proband. That is, even though they themselves did not express the phenotype, the unaffected cotwins had the same genotypic susceptibility to bipolar disorder as the probands, and therefore the observed MZ

twin discordance could be attributed to nongenetic factors.

The search for the genes that leave one vulnerable to depression has been a bit more successful. The dopamine receptor and transporter gene, the Tyrosin hydroxylase gene (an enzyme gene), the NE transporter gene all have been implicated in various studies. Unfortunately the search for the depression gene has been frantic and have led to half-baked results, such as the 5HT TLPR gene, recently shown not a link.[70]

Note that the quote above talks of bipolar disorder, not unipolar depression. However: "a relationship between recent adversity and the onset of depression is generally accepted as proven . . . ", though the relationship is complex. Later in p. 94, "most common diseases, and not just psychiatric ones, will depend on the combined action of multiple common gene variations together with environmental risk factors". Kalidindi uses this to show gene testing will be limited in use, but the same data prove a partial genetic basis to mental illnesses is not a block to an ideal society.

10.1.2 Evolutionary psychology

Mental disorders are seen by evolutionists as caused by six possibilities:

1. The EEA where our minds were forged not matching today's societies.
2. Coevolution of infectious germs which affect the brain and coevolution from competition within the species leading to extreme unstable traits such as creativity.
3. Trade-offs in adaptive design.
4. Constraints in selection operating incrementally.
5. A trait increasing reproductive success but emotionally negative.
6. A defense mechanism analogous to the physiological mechanism of fever.

Evolutionary psychology distinguishes between disorders caused by brain abnormalities, such as schizophrenia, autism and bipolar disorder, and the other disorders. The genes which dispose one to schizophrenia have stayed in the population in low numbers for a long time. This is explained by natural selection not being powerful enough to weed out the possibly many genes which lead to the vulnerability. The other possibilities are the genes are linked to others which are beneficial, or the disease is a cliff-edge effect from a mental characteristic getting sharpened from reproductive competition. As far as ADHD goes, to quote from the Handbook: "As for the capacity to sit in one place indoors for hours under enforced contact with a boring book, that is so far from anything the natural environment ever required, it is astounding that any of us can do it." The ideal world hence should not have a formal education system with set hours.

Emotional disorders, anxiety and depression, are seen as defense mechanisms causing us to drop a particular strategy which leaves us in a low mood. It also may be an involuntary yielding, a submission, which stops further humiliating attacks or being trapped in an impossible quest. Eating disorders leaving one obese are seen as being from dietary habits acquired during our hunter-gatherer days not being suitable to the sedentary work and life style of industrialized societies.

Note, in general, the psychological mechanisms underlying disorders follow the same input, processing, output model. They are triggered by sensory, social and developmental input. Spontaneous malfunctions happen only when the brain circuitry, the basic hardware, is defective.

10.1.3 Neuroanatomy

Neuroanatomical defects have been seen for schizophrenia and some affective disorders. For schizophrenia a pruning that happens during adolescence fails to happen. Whole brain and hippocampal volume are seemingly reduced in schizophrenics. Cause and effect have not been clearly separated. Neither are the roles of genes and the environment. This is true for other major mental disorders as well.

10.1.4 Neurochemistry

Dopamine blocker drugs, phenothiazines, reduce psychotism and one theory was the disease was caused by an excess number of dopamine receptors activating. This is no longer considered tenable since newer antipsychotics, atypical antipsychotics, also work as well, but affects serotonin function. The neurotransmitter glutamate and its receptors have also been implicated, since glutamate receptors are fewer in schizophrenic brains, at least as seen on an autopsy. Glutamate blockers such as ketamine can mimic the symptoms of the illness. However glutamatergic medication does not reduce symptoms.

Similar results hold for most other disorders. Antidepressants increase levels of serotonin, often by inhibiting its removal from the system, with SSRI (Selective Serotonin Reuptake Inhibitor). This treats the symptom. The root cause is suspected to be genes generating attitudes worsened by social situations.

10.2 Behavioral traits: competition and hierarchies

The word compete is from the Latin root competere, to seek or strive together. The meaning has changed over the centuries. In popular parlance it now means the opposite. Competition can broadly be defined as rivalry between persons, groups, nations or animals for any objective. In the real world, the objectives are either resources such as food, territory, sex, or achievement. Competing for resources is often biologically motivated and can be seen in babies. Where resources are sufficient, such competition becomes moot. Unlike other species, humans are intelligent enough to exploit resources in their raw form. For a chimpanzee, nuts, fruits, stems, shoots and leaves are the only food resources. Humans can cultivate food, store it, transport it and use it. They can synthesize artificial food combining nutrients the right way. The word resources, when applied to humans, means something different. It is the list of raw elements present and accessible with today's technology. Looked at this way, there is no shortage.

Competing for achievement is to be better than somebody at a physical or mental activity. To run faster, throw harder, play soccer and win, to solve a problem before somebody else does, or to produce something better and quicker than another person or team. In some cases this is motivated by rising up the social hierarchy through excelling at something, and in others by the rewards of money, fame or historical acclaim. Climbing the hierarchy is not unique to humans, other primates also do it. I will examine this form of competition at the end.

10.2.1 Behavioral genetics

We may innately tend to compete for money, fame and historical acclaim. Behavioral scientists, in general, have little to say on the subject. They have focused on biological competition for resources, and even there some like Stephen Jay Gould believed the survival instinct became less innate and more learned in humans. Sociologists and anthropologists have analyzed human competitiveness in its achievement-driven form. It is also an integral part of economics since both our education and economic systems are built on it.

Man has made most of his greatest inventions before there was money or a means to record achievement. Taming fire, domesticating pets, writing and agriculture are comparable in quality and impact, and their inventors could not have been motivated by a historical legacy. There was no way to record their deeds for posterity. Curiosity and need would have driven them. Lighting a fire, fanning a flame, and dousing the embers; pictograms on parchment; to sow, till, grow and reap; our greatest inventors have their names in no hall of fame.

Genes can push us to compete in the same way they leave us open to mental illness. Their influence can be felt only with a matching environment. Anthropologists such as Margaret Mead believed competition was cultural. [REF HERE] Despite her association with the parapsychological association, Mead was an adjunct professor at Columbia University, from where she had received her doctorate.

Animals do not universally compete, even for resources. The pygmy chimpanzees do not compete for food, they share.

Hierarchies are tied to competition. There is a theory hierarchies are needed for orderly functioning of society. A few decades ago, the animal world was held up as an example. Kano, p. 219: "Western researchers of animal behavior have tended to regard the rank system of hierarchical relations as the main plank supporting society." The research referred to is from Lorenz, *On Aggression*, Ardrey *The Territorial Imperative*, and others.

Kano, who studied chimpanzees, mostly the pygmy one, for decades differs strongly:

> A comparison of the two chimpanzee species, however, seems to argue against individual coexistence arising from fixed hierarchical relations . . . Thus, in pygmy chimpanzee society, the dominance hierarchy is relatively undeveloped and does not seem to operate as clearly as in common chim-

> panzee society.
>
> If we compare these two species in terms of social phenomena such as group size, patterns of fission and fusion, intergroup aggression, and conspecific killing, we find that pygmy chimpanzees are more successful at individual coexistence than common chimpanzees. This implies that genuine coexistence will not be gained by the establishment of strict hierarchies but rather by the establishment of harmonious relationships based on equality among individuals.

One could say this reflects Kano's cultural bias. But in the next page, he presents his view of the roots of human hierarchies:

> The early hominids hunted and gathered food on the savanna. In the present human population, the hunting and gathering people of the Kalahari Desert practice the subsistence economy most similar to that adopted by the early hominids. In those people, there is no hierarchical ranking among males; the level of aggression is very low; and they form an egalitarian society (Itani, 1987). This example supports my supposition. If there had been any male aggression among hunting people in the millennia since the time of pair-bonding, it was selected out over a long period of time, and all that remains is the aspect of sexual competition.
>
> Lorenz (1966) and Ardrey (1961) were wrong in thinking that human aggression was inherited long ago from hominoid ancestors. Instead, I agree with V. Reynolds (1967) that the aggressive and hierarchical behaviors found in existing human males appear to have originated secondarily, perhaps after the advent of farming. Farming is closely tied to sedentary habitation and increases the carrying capacity of the land. On the other hand, compared to a foraging subsistence, farming leads to the drying up of resources, and is subject to the influences of natural calamities. Because of these effects, the defense of one's territory becomes a vital matter. The budding of territoriality in human history may have occurred after the commencement of farming. In order to defend territory, fighting between neighbors became necessary. Moreover, farming, storage, and private prop-

> erty are tied together, and private property implies the need for defense. It also leads to the stratification of society and eventually to inequality among its members.
>
> I suspect that aggression in human society developed after the emergence of agriculture, . . .

Though Kano focuses on aggression, his argument hinges on the rise of hierarchies and territoriality in human societies. Since the pygmy chimpanzees do not have the strong hierarchies seen in other primates, the common ancestor of chimps and man probably did not have it hardwired either. Humans developed it as a social, cultural and economic artifact. The pygmy chimpanzee stands in the way of easy extrapolation of a few decades ago from other primate societies to humans.

Klein echoes the same thought:[71]

> . . . the pattern of male violence differs significantly between common chimpanzees and people in those historic human societies that are most relevant for comparison. . . . Historically, homicide rates in such [hunter-gatherer] societies sometimes approached those in modern industrial societies, but unlike "panicide" rates, they were due mainly to sexual jealousy between males within a group, not to conflicts between males of different groups. The difference arises primarily because unlike neighboring chimpanzee communities, neighboring hunter-gatherer groups usually share access to key resources. More complex human societies generally do not, and it is their competition that gives rise to a high level of intergroup male violence.
>
> The sum suggests that male violence in common chimpanzees and living humans has different roots. . . . Thus, human male intergroup violence probably came to resemble the common chimpanzee pattern only late in human evolution and it resulted from social change more than from shared genes.

Behavioral geneticists and psychologists do not recognize competitiveness and hierarchy climbing as traits. They divide personality traits into five big groups: neuroticism, extraversion, agreeableness, openness and conscientiousness. Some important subtraits are novelty seeking, harm avoidance, reward dependence, impulsiveness, exploratory behavior and disorderliness (Plomin, p. 367).

All behavior, including competitiveness, is considered some combination of these subtraits. For most personality traits, heritabilities in the 30% to 50% are typical. Which means the variation in the traits is from genes and the environment combined. Once again we are faced with the predisposition model.

10.2.2 Evolutionary psychology

Status, prestige, respect and rank exist in all cultures. Status striving is universal. A dominance hierarchy is one where some in a group reliably own better key resources. These emerge via people assessing one another's competitive and fighting abilities to form a ranking system. Selection favors evolution of assessment mechanisms based on physical strength, ability to enlist powerful friends, social network connections, and the size of the kin group of each combatant. Strategies of dominance and submission can also be expected to evolve, following the assessment. Increased sexual access to females is the adaptive rationale for dominance-striving. Hierarchies, at least in other primates, tend not to be static.

There are sex difference in attitudes toward dominance and hierarchies. Men regard egoistic dominant acts, such as managing to get one's way, as more desirable. Women prefer prosocial dominant acts, such as taking charge of things at a meeting.

There are two basic theories concerning dominance and hierarchies. The first, dominance theory, proposes humans evolved reasoning as an adaptation to deal with processing social norms involving dominance hierarchies. Reasoning about group rights and obligations is called deontic reasoning. Children start deontic reasoning, and understanding the transitivity of dominance hierarchies (if A dominates B and B dominates C, then A dominates C) early in life. Dominance theory considers deontic reasoning a separate module from the other type of reasoning, indicative reasoning. This is a theory not of hierarchies, but of reasoning.

The second theory is the social attention-holding theory. Social attention-holding potential refers to how much and how well others pay attention to a person. Per the theory, humans compete with one another to be attended to, and valued by, others in the group. Somebody who draws more attention goes up in status. Going up has two consequences: the mood of elation and willingness to help others more. Going down also has consequences on mood and emotion—social anxiety, shame, rage, envy and depression.

Evolutionary psychology assumes status or rank marks access priority to resources in competitive situations. It is hence directly related to inclusive fitness driving selection. Higher status and a dominating nature improves sexual access to women, per studies.[72] Socially dominant people have been found to be better at deceiving others, persuading others, and interpreting others' intentions. They also form strong alliances through reciprocal obligations.

Competition and hierarchies hence result from competition for resources. They are triggered only in an environment where either resources are insufficient, or sufficient but not shared. A society with sufficient resources and sharing them among all would not see hierarchies forming. The adaptation to strive for status, subconscious, would be there, but it will not be triggered. The input that gets us to climb hierarchies is the better access to resources that generates. How people decide their place in a hierarchy, and how they stay in place, will not be a concern where the environment to form them is nonexistent. Many popular books on the evolutionary take on hierarchies focus heavily on these two part.[73] They claim correctly hierarchies exist in all cultures and always have. The implied conclusion, that they will always exist, is however not supported by data from EP. All we can conclude is that competing for resources, including sex, has been common to all past societies.

10.2.3 Neurochemistry

Perceived social status influences hormones and is influenced by them. Citalopram, an SSRI, increased dominance among an experimental group. Changes in social status influence androgen and serotonin levels. Cortisol levels tend to be high in submissive individuals. Testosterone rises in those boosted by winning a sports tournament. Our response to hierarchies is reflected by hormones.

10.3 Behavioral traits: jealousy and envy

Though common usage considers envy and jealousy the same, psychologists consider them different. Envy is wanting something somebody else has. Jealousy is worrying about losing something someone already has, even when it can be shared. Jealousy is tied to possessiveness. Envy is not a concern for a sharing world. Jealousy is.

Sexual jealousy has been common for much of history. But it is not universal among primates. Neither species of chimpanzee is sexually possessive. The common chimpanzee does sometimes monopolize and consort with a female, but females are largely promiscuous, and males polygamous. The pygmy chimpanzee is completely promiscuous. Sexual jealousy is not constant across human cultures either. The West of the 21st century is sexually less possessive than the same culture two centuries ago, or others even today. Surveys show female virginity prized in India, China and other places.[74] In the West, surveys do not ask the question anymore. Sexual jealousy is social and cultural behavior.

What about other kinds of jealousy? In pygmy chimpanzees, a younger child does act jealous of an older sibling (Kano, p. 172). In humans, infants have been shown to be jealous about their mothers at 3 months of age. Maria Legerstee, a psychology professor at York University, found when three-month old babies saw their mother's attention being distracted, they became agitated. They smiled less and turned away more. They also screamed, kicked their legs and turned around in their seats when researchers talked to their mothers deliberately excluding them. A one-way monologue did not elicit jealousy, while an animated conversation did. The results are new and not yet published.

The research just proves infants can be taught to be jealous at a young age. It does not apply to newborns. A newborn is not possessive about its mother. It has few behavioral reactions of any kind. During the growth phase, its personality can be molded many ways, from an early age.

10.3.1 Evolutionary psychology

Evolutionary psychology analysis of jealousy focuses, laser sharp, on sexual jealousy. All other forms are reducible to it, in the sense owning fewer things handicaps one in the mating race. All jealousy is hence considered an adaptation which propels one to acquire or retain possessions and mates to improve reproductive fitness.

This adaptive mechanism needs to be calibrated during the formative years, and needs input from the social context. The calibration is about what is required to attract and retain mates, and depends on the culture. The contextual inputs are situations where there is a threat of losing what you have, or not getting what you want, from a mating perspective, directly or indirectly. An ideal world has to be one where such do not occur. No one should have to fear losing anything or worry about how to gain anything, including sex. Jealousy can be removed only by sharing everything and meeting all wants free. This is both required and adequate to remove this negative trait.

10.4 Behavioral traits: hate and violence

Human violence, against other humans, exists everywhere and has existed throughout our long past. That violence is basic to us, and nonviolence something to be trained and learned, is widely thought true. Many also consider asking others to hold in their aggressive instinct, dangerous. The Prince of Peace was, after all, crucified. It is the one part of his story most find easy to believe.

Violence is a well-studied subject. In the big 5 model, it comes under neuroticism. Lesch covers this along with anxiety in some detail in Plomin's book. He starts with: "Even though individual differences in anxiety and its behavioral consequences are substantially heritable, they ultimately result from an interplay between genetic variations and environmental factors (i.e., epigenesis)." He considers the amygdala, a brain region inherited from reptiles, involved in the conditioning of anxiety, and the hormone 5HT during the growing years as responsible for wiring up the amygdala. Genes which affect 5HT function would hence affect the innate disposition to anxiety and related behavioral traits.

10.4.1 Evolutionary psychology

Evolutionary psychology theorizes adaptations for aggression, homicide, and warfare. These adaptations depend on the context. Evolutionary psychology says there are causal situations in which particular features of the perpetrator, victim, social context, and adaptive problem are likely to produce aggression as a strategic solution. The aggression module kicks in, responding to specific input.

Aggression is common in animals, but warfare is unique to chimpanzees and humans. Aggression is expected to have developed for the obvious adaptive reasons: snatching resources from others, defending self and kin, dealing with intrasexual rivalry, climbing the status and power hierarchies, as a deterrence, and to block mate infidelity. Aggression is expected to be stronger in men, since selection will favor risky tactics among them for mate access, given some degree of polygyny causing unequal sharing.

The contexts for men on men violence include:

· Being unemployed.
· Lacking financial resources to pursue mating.
· Status or reputation being threatened.
· Sexual poaching of a mate.

Women on women violence is expected to be from intrasexual competition for men. Men are violent with women in a sexual context, primarily jealousy, functioning evolutionarily to deter infidelity, and promote the mate bearing one's own offspring and hence genes. Women on men violence is expected to be mostly in self-defense. Empirical studies bear out the predictions.

Warfare is expected to have evolved for increased sexual access to women. Murder is possibly due to a slip-up resulting from brinkmanship gone wrong.

Contrary to the popular myth, EP does not imply men have an "aggression instinct" in the sense of some pent-up energy that must be released. Rather, men have inherited from their ancestors psychological mechanisms sensitive to contexts in which aggression probabilistically leads to the successful solution of a particular adaptive problem.[75] Buss dedicates many pages of his text to exploring these contexts. I summarized this above. An ideal world has to ensure none of these occur. This means no stable groups, group competition, rewards for status or reputation, money, barter and no preferential satisfying of the male copulatory want. The last should be universally satisfied, since the female masturbatory want does not clash with it.

Note this does not mean we will suppress aggression by conscious means, or for fear of punishment. Fear of punishment, in EP terms, suppresses aggression by increasing the costs to outweigh the benefits. In the ideal world, the inputs which trigger the aggression module have to be absent, and hence the exact tuning of the module would be irrelevant.

10.5 Behavioral traits: group formation

Group formation is seen in most great apes, except the orangutan which leads a solitary life. The nature of the groups vary between the apes. Groups are closely tied to foraging behavior, that is their nature depends on how the species obtains food, which depends on its environment. Different communities of the same species form different kinds of groups under different environments. This points to an environmental influence on group formation. In other primates, both genes and the environment decide how groups are formed.

In humans, the nature of groups varies across cultures and has varied across time. In general, humans form social groups of more than a 100.[76] Most are tied to physical nearness. Our social groups provide psychological comfort, but rarely are needed to satisfy physical wants. Their nature is tied to the nature of the overall society.

10.5.1 Evolutionary psychology

As we saw, EP uses reciprocal altruism to explain how groups form. As noted there, this works on the idea of benefits from returned favors outweighing the costs of the favor.

Evolutionary psychology does posit reciprocal altruism is based on a calculation of costs and benefits. The calculation may not be conscious, but it exists based on the social context. The reciprocal altruism module is not believed to be hardwired to the cost and benefit balance of the environment in which it arose. That calculation itself is external to the adaptation module, and can be considered one of its inputs. In the ideal world, this input has to have a different value, since group formation leads to preferential treatment.

Making the cost of a favor nil effectively disables reciprocal altruism. People will do favors not out of altruism, but because it costs them nothing. In the ideal world, the costs of a favor would be almost nil. Where resources are shared, no resource cost can be put to any favor. The only costs would be the time spent on the favor, time which could otherwise have been used pursuing a mating strategy and that way passing more genes to offspring. Where there is no mating strategy to think of, the cost of the favor is nil. Costs related to survival, finding food, and so on, are also minimal in the ideal world. Or even in our industrialized nations.

In such a world, reciprocal altruism will not trigger us to behave the way it does now. Long-term alliances and groups will not form the way they do in today's worlds. This conclusion is not based on whether we innately tend to group. It is based on exactly how we tend to form groups, and how the mechanism reacts to the social setup of a free world.

Specifically, apart from groups containing kin, humans are believed to prefer those who cooperate and can be trusted. People look for those who signal they will be around in the future, being familiar or showing commitment. People also prefer to mix with those whose behavior they can predict, which implies similar backgrounds. In general people mix preferentially with others who provide a fitness benefit as opposed to indiscriminate mixing. Evolved preferences for some types of partners means discriminating against the rest.

People tend to punish those who enjoy cooperative benefits without contributing. Anger is the proximate mechanism driving punishing free riders. People also have mechanisms to protect against attack from out of group members, indicated by angry expressions, rapid approach, weapons and so forth. We also have adaptations designed to minimize being exposed to infected people. Disgust at discharged bodily fluids and deviation from species-typical morphology (missing limbs, skin conditions and the like) arise from this.

Balancing this, people have adaptations which evoke sympathy for those unable to contribute from illness or injury. An evolved mechanism which drives this will trigger only for those whose disabilities are temporary, since reciprocal altruism is only then meaningful. We are also expected to feel empathy for the handicapped, set against disgust.

In the ideal world, the cues people look for to form groups have to be absent. The concepts we have collected so far show this requirement is already met. Tendency to cooperate and be trustworthy is only mildly heritable, as per behavior genetics. Familiarity will not exist where our other adaptations, curiosity and wanderlust, cause us to grow up the children of many places. Mixing preferentially with those of the same background will not be an issue, since backgrounds are going to be equally mixed for everyone.

Language and ethnic barriers, a byproduct of familiarity seeking, will not exist since a universal language will evolve, and ethnicities vanish.

Disgust at handicaps has been outweighed by the sympathy adaptation through history. With better medicine and technology, the risk of catching infections from others comes down dramatically. This reduces the cost of empathy.

10.6 Summary from the academic side

We are not born blank slates. Nor are we a mix of good and bad. These popular, cryptic, viewpoints hide how complex our true nature is. We are born with potentials, vulnerabilities and free will. In our worlds free will is trammeled by the lack of choices. The need to earn a living leaves us not free to choose a lifestyle we like. From geneticists' view, this is good because it enables them to better separate the two remaining elements which influence behavior, genes and the environment. The data they have collected on how genes and the environment interact to create behavior enable me to show how inborn potential and vulnerabilities would develop in the ideal world.

Evolutionary psychology has our mind being made up of processing modules which originated to solve the specific problems our ancestors faced. These modules are calibrated during childhood, and once completed in adults, still take the environment as input to produce behavior as output. We can consciously override their output in many cases. These mechanisms are unlike what psychology used to call instincts in the past, since those were expected to be spontaneous, not requiring an input to trigger them.

The ideal world has to be so that children are brought up with the modules not calibrated to generate the negative behavior. In addition, the inputs to trigger the mechanisms should not happen, as a safeguard to dampen and remove the effects of a few deviating for any reason. In both cases, the mechanisms which generate negative behavior will lie dormant and inactive.

10.7 The popular perception of genetics

The public believes statistical research shows genetics drives a large part of feelings and attitudes. These studies have to be narrowly interpreted for many reasons:

First, the Internet media publishes every report showing a connection between DNA and behavior. Those which show no linkage typically get ignored, though they are equally valid evidence. Scientists would accept a genetic basis to behavior only after multiple surveys in different regions prove the same link, and negative results are explained precisely.

Second, we do not know how genes work even at a gross level. So for behavior to be established as genetic, all other possibilities have to be ruled out. Research on identical and fraternal twins is a classic example. Identical twins share both biology and usually life experiences. Studies ensure they have different school or work background. But identical ones look more alike than fraternal ones do. Hence they are often treated similarly by strangers on a first approach. The first impression people have is the same. Since many people react to them the same way, they share a common experience for many parts of life. Since this is too hard to deal with, psychologists ignore it in their studies. Such conclusions are correct only if confirmed by other evidence or analytic reasoning. Another example is studies on twins raised apart. The samples are convenient from a genetics standpoint, but bad ones for analysis of psychology. They are small and clearly the subjects have grown up in an uncommon environment since it is unusual to separate twins. Foster care and broken homes are a likely shared background for siblings growing up in different places.

Published papers mention these caveats. The scientific community considers such results provisional. It takes years for results to harden into established fact. The popular media, by presenting every transient study result as a "gene for x found" headline, simplifies beyond correctness. The scientific consensus is in Plomin p. 389: "After all, it is no longer controversial whether nature or nurture shapes human development and personality; the issue is how complex genetic and environmental factors interact in the formation and expression of a behavioral phenotype." Less catchy. I avoid quoting from popular science books for this reason—the simplifications they make might be appropriate for the theme and context of the particular point they cover, but the arguments here need the original details.

10.7.1 Mental diseases exist

Whether mental disorders are biologically based is best answered by tackling the question differently. Reasoning and emotions are based in biology since all processing in the brain and the body is biological and chemical. As such all illnesses including psychiatric ones are reflected by the person's biological state at that time. What matters to us is whether people are born with these illnesses. The other explanation is the imbalance, say in a chemical like dopamine, is the brain's reaction to the mental trauma the person has been through. Data suggest in some cases people are born vulnerable to diseases such as schizophrenia and the environment pries open the small chink to drive them past the edge. We are ill-equipped to deal with irrational societies anyway. In place of logic most people imitate what others do to cope with life in these. The term genetic predisposition effectively means 'genetic difference which leads to mental illness in our societies'. Psychological illness is best viewed as caused by lifestyle aggravating innate differences in us. In this respect it can be thought similar to physical conditions such as high blood pressure.

10.7.2 We will always be jealous and compete

Our emotions come from two elements: what we remember and how we react to events based on some reasoned thought. We get jealous if we lack something somebody else has or is thought to have. We compete to win things, mostly for money, sometimes to be admired and thus to get others to behave nicely to us. Negative attitudes such as jealousy and competitiveness are influenced by learning for three reasons:

First, the computing involved which decides when and where a person gets jealous is unmanageably complicated. Hence how a green gene works in humans has to be exceedingly complex. We feel jealous about things related to sex, money and social or cultural mores. Thinking of programming a robot to be envious immediately shows the trouble with considering this emotion intrinsic. It depends way much on our old experience. As a result it is better viewed coming from subconscious reasoning applied to current events based on past memory. In EP terms, events trigger a hardwired module calibrated by previous experience, to generate jealousy. Its programming would hence depend on (1) memory of past experience; (2) automatic reasoning based on what gets us hoped-for pleasure, where the hope itself draws on memories; and (3) what we see, hear, read or sense in some way blocking us from that hope. Every one of these is influenced almost completely by our social environment. Any programming to form groups and compete has a similar basis.

Second, statistical studies do show gene differences for those reacting differently in tests used to check who feels more possessive. Serious researchers do not consider the study results established fact since the experiments are simplistic. Standard texts on behavioral genetics do not contain many of the reported studies. They are conducted on a few people and ignore their previous experiences. All the tests prove is in some cases some genes expose people to life experiences which leave them that way. This does not mean the gene codes for envy. It means our competitive societies exaggerate every little genetic difference forcing people who are different more into negative actions. What we have been through scars us and molds our behavior.

Third, people can be brought up to not covet things. In EP vocabulary, either the calibration or the input to the jealousy module is adjusted to deactivate it. Cults do it. The rich too do it, at least with regards to money. They do not tinker with genes. Instead they change what a person sees, has, and gets, to get beyond envying at least a few things. Many people believe jealousy inherent since it has been with us forever. Past and present cultures have dealt with it by preaching all are created equal and would enjoy similar opportunity in this life or the next. The preaching has never worked. This is not because we are innately envious but because the preaching has been a lie in the past. We are not born exact equals and no society has bothered to even remotely consider equal access for the sex want.

10.7.3 We will split into groups and be selfish

We form units to logically deal with competition. The ideal society would extend this group to all humans. We will be part of a temporary team at a given time to do some specific thing. Unlike other animals humans remember and automatically recall most of the past. These memories largely shape how we behave. The cliques we form are based on work, school, social or economic background. A gene that limits us to form small blocs only, overcoming the dominating influence of our memories, would again be so complex its working cannot be described algorithmically.

Note that selfishly caring for basic needs is not a negative trait. Whether that is innate is immaterial. The right society handles this guaranteeing everyone's wants free. This makes sure people can get along holding a selfish desire to satisfy innate urges. For this to work our wants should not be clashing and there should be enough resources to satisfy everyone.

10.7.4 We are born violent

Humans are born minus claws, tusks, horns, or sharp teeth. Naturally, with no training or weapons, most people find it physically difficult to materially injure another because of the sheer nature of our anatomy. Over time, training and distressing experiences lead us to physical violence. The distress is often from the conflict inherent in our mating systems, with men and women looking for, and forced to look for, different things.

10.8 A new view

Chapter 11 on page 229 will prove resources are aplenty, and outline a society where our wants do not clash, all of us are totally free, and technology progresses to consistently improve quality of life.

Are we equal? will not be a concern since we will all just help one another and not care. People growing up in a society where all share everything and cooperate without competing will be free of the bad emotions of envy, greed, revenge, group formation and sadism so common now. These brain calibrations develop from how they remember what they see, feel and are subject to while growing up. All experience is recorded as neuronal connections. As a result, sections of the brain processing these emotions would be bigger in some than in others. This does not mean they are from birth more prone to be that way. The brain adapts to the social environment, extensively while growing up, less so but still significantly at adult stage.

My view is societies can be changed to remove reasons for people to be jealous, vengeful, competitive or violent. Persons who grow up in a sharing world will learn and accept its ways and values. Once established an ideal society will not slip due to any innate, genetic negativity. The innate dispositions, as the genetics data show, are for micro tendencies which can be combined and molded by the environment in various ways to generate visible macro behavior. To see this intuitively, think of how you, a person, a single he or she, would behave if all others behaved the way described in the ideal society. With bad experiences absent, if you behave in a positive, sharing, way, it is sensible to assume the rest will too. Those at the receiving end of an unfair or unjust action mostly wind up being unfair and unjust to others. In our current system negative attitudes in different people interact and amplify one another. Making us wrongly feel they are impossible to get rid of. However social conflict mentally harms everyone and also corrupts progress especially in science and technology. Social change is humanity's most urgent task.

11 The ideal world

. . . finally to the path you must create by yourself, alone in the dark . . . whether you want it or not, whatever seas you have crossed, the way home . . .

Gravity's Rainbow Thomas Pynchon

I have explored the nature of our sex drive, love and attachments, negative emotions, competitivity, possessiveness, mental illness, violence and jealousy. Based on the analysis, an ideal society with everything commonly owned and all wants met free can be built if there are sufficient resources to satisfy everyone.

The previous chapters outlined what an ideal society should be, to ensure negative traits would not be triggered. To recap the findings:

1. The male sex want is copulatory and largely indiscriminate, while the female one masturbatory. For this to be satisfied, males should be able to mate free with any woman, when they feel the urge.
2. To avoid triggering the adaptations of jealousy and possessiveness, we should share everything, and own nothing individually. This means no money and no barter.
3. To bypass triggering mating preferences, pair-bonding, love including maternal and paternal love, and attachment, children should be brought up by everyone, not their biological parents. The adaptations of curiosity and wanderlust ensure that if children are left free, they will move from place to place on their own.
4. To avoid group preferences based on shared background and language, children should not be brought up in a single region. This ensures a common language would develop.
5. To avoid groups forming based on reciprocal altruism, all wants should be met free. Food, drinks, shelter, restrooms, sex, travel, communication should all have no cost to an individual. They would belong to everybody. When something I do to benefit you does not cost me, I do not have to bother about reciprocity, that is keeping track of favors, making sure others do not cheat on returning favors, forming groups to keep those we have favored close to us, and so on.

6. Since we are not made to sit in a place and listen to a lecture for hours, schooling should not be formal. Children should learn watching adults. Only the most basic things, walking, talking, hygiene, reading, writing, accessing the internet, need be shown to them.

Our liking for specific landscapes may lead us to mimic canopies in the dwellings we build, and occasionally wander into the wilderness, well-prepared. Evolutionary psychology explicitly states the love of wilderness is not related to us preferring to be lonely, or to get away from the noise of the modern world. Our fear of snakes, spiders and heights will be immaterial in the ideal world; they mean little even in today's industrialized countries. Food preferences become maladaptive only if we build societies where the wrong kind of food is more available. Where food costs money and the cheapest type is full of sugar and fats, one can expect any obesity-disposing gene to kick into high gear. In the ideal world, stress and forced work absent, people would begin to eat healthful food. Once the tradition kicks in, it will spread and strengthen, since cost of food would not be an issue.

11.1 Resources

The only thing left to prove is our resources are sufficient. This section establishes things are so. Then I paint a picture of the ideal society in words.

Main resources we need are food, water, energy, living space, and material to construct machines, dwellings and other buildings. Resources are what we can use based on current technology. The cost of the technology is not material, since that is typically calculated in terms of our current societies, where only a small fraction has the skills to use it, and that too in a competitive setup, with wants tied to work.

11.1.1 The food we need

I will focus my analysis on plant life at the bottom of the food chain. Plants need water, sunlight, oxygen, nutrient and carbon dioxide to grow. Soil is unnecessary. The major nutrients are nitrogen, phosphorus and potassium with trace amount of iron, zinc, boron, sulfur, copper, calcium, magnesium, manganese and molybdenum also required. One ton of wheat uses 25 kilograms of nitrogen, 3 kg of phosphorus and 7 kg of potassium. Following is a list of the quantity of these on earth in the crust, the oceans and the atmosphere.

Table 11.1 Resource inventory

Element	Symbol	Abundance (million tons)	Source
Aluminum	Al	2 million million	Crust
Boron	B	4.44 million	Ocean
Calcium	Ca	412 million	Ocean
Copper	Cu	1500 million	Crust
Iron	Fe	1.3 million million	Crust
Magnesium	Mg	1290 million	Ocean
Manganese	Mn	2600 million	Crust
Molybdenum	Mo	10,000	Ocean
Nickel	Ni	2000 million	Crust
Nitrogen	N	4000 million	Atmosphere
Oxygen	O	1000 million	Atmosphere
Phosphorus	P	60,000	Ocean
Potassium	K	399 million	Ocean
Sulfur	S	905 million	Ocean
Zinc	Zn	1800 million	Crust

Note these are rough estimates. But they are heavy underestimates since we focused on just one source for each element. Oxygen, for example, is present nearly unlimited in the sea as H_2O, water. Carbon dioxide is about 0.03% of the atmosphere, which comes to 1.5 million million tons in weight.

There are resources to grow million million tons of wheat. Another major resource, salt, is abundant in the sea. These elements get recycled after we consume them as meat, fruit, grain or vegetable. Only a small part of carbohydrates gets converted to energy and changes from matter form. Molecular composition of elements changes as they move through the food chain. Humans have the intelligence to figure out how to convert the end product back to fertilizer. We can recycle these elements efficiently, to cater to a multiplying population.

11.1.2 Water to drink

Oceans have 1370 million cubic kilometers of water in total. Volumetrically this works out to a staggering 1370 million million million liters. Sea water is now distilled to extract fresh water. Water is to be found in plenty on earth. By the time the population multiplies to the point where this supply is insufficient we will find other sources. With technology to expand out to space, we will mine ice from comets, other planets and their satellites. Frozen water is to be found throughout the solar system and outside.

11.1.3 Energy to burn

Our energy sources are many and varied. The earth receives an average solar insolation of 200 w/m^2 after clouds and the atmosphere absorb, and earth's albedo reflects, a part. Translating to a net input of 100,000 Terawatts. As of now, we consume 17 Terawatts. Net solar energy exceeds immediate future requirement. This assumes a two-dimensional cross section. Panels can be hung farther out in space to tap more sunlight. Wind power is estimated at 72 Terawatts. Superheated groundwater, geothermal power from geysers, and deep wells dug into hot dry or magma rock are other major energy sources. Tidal power utilizes gravity and the kinetic energy of the earth and moon system.

We can exploit solar power with solar photovoltaic cells, thermal collectors, thermal-electric power plants, and sails to power spacecraft. We can harness wind power with turbines. Nuclear reactors could use both fission and fusion. Fusion energy is nearly unlimited. Lithium- and deuterium-based systems have already been prototyped. Deuterium-only ones are a good choice since this hydrogen isotope is abundant in the sea. Down the road we can mine Helium-3 for fusion reactors on the moon and gas giants.

11.1.4 Living space

With large group dwellings, living space required would be reduced by orders of magnitude. Heating and air-conditioning free us from living only in moderate climes. We need no longer be restricted to the surface of the earth. Breathable air extends miles from the surface and this three-dimensional space can be utilized to live in floating dwellings. And grow plants hydroponically. Further out in time we can terraform other planets and star systems to live in. Humanity can achieve such engineering and technological marvels. Our societies need to unleash the will to get there.

11.1.5 Metals and minerals

Silicon, used in electronics and to make glass, is plentiful in the form of sand. The raw materials for steel—iron, carbon and nickel—are also abundant on earth. Aluminum exists in large quantity in the earth's crust. Refer table 11.1 on page 231 for details.

11.2 The true world

Once sharing everything and having wants filled free are accepted, the details fall into place. As I showed, the male sex want is copulatory and the female one masturbatory. Filling wants free means women giving sex free to all men, and having their pleasure on their own. It also means no group educational system in childhood, with children learning by watching adults. Where everything is shared free, money has no meaning, and a work system built on it cannot exist. People would work out of curiosity and a psychological need to do things; we don't like to sit around doing nothing for hours. With no private resources, the family system cannot exist and children will be brought up by all adults, and this means they will move from place to place following their wanderlust, once old enough to do so.

The true world is hence one where we share everything; work when we feel; and are free to follow what interests us, with no borders of state or country in the way. Where all are convinced it is right to eat when hungry, drink when thirsty and sleep when sleepy. And women believe it right to give sex free to all men and get their pleasure on their own, with everyone jointly responsible for children.

Many will initially recoil at this for our societies bring them up to reject such a view. I hope to have changed that attitude by separating free sex from men dominating the world and by clinically analyzing women's urge and pleasure. The vision pieced together here frees them too in all ways. It makes everyone, not mainly the mother, responsible for bringing kids up. It removes harassment and discrimination, and lets women do what interests them the same as a man. Unlike in our societies, in the ideal one they will not have to deal with angry, upset or violent men.

Below is a report on an ideal society of the future by a person in it, directed to one in ours.

11.3 How we live

Our way flows from what we are, lightly seeping through the social fabric losing or leaving little behind.

11.3.1 Where we live

There are only group houses which are similar to dormitories or college hostels of the past but without separate rooms. These are used to sleep or stop by when tired. They have beds, cots and cozy furniture along with sheets, pillows and blankets. Shelter from nature—sun, wind, the wet, the heat and the cold—decides the design. With detail depending on soil and clime. Dwellings have central air-conditioning and heating unless the climate is mild year-round. And are sealed to keep out all that bites, sings or stings. They are located far from forests or savannahs.

A building is designed and built on engineering principles. Function drives the form. Most buildings keep out the sun and the sweat, the snow and the shivering. Fashion and beauty are now meaningless criteria.

Dwellings are proofed against quakes, flood and fire. Such residences come in all sizes and shapes but share the same sound basis of group living with nothing private and no owner. Walls bear the load of a roof which keeps out sun, snow and shower. Partition walls of the past no longer exist since they were only for privacy. Windows of glass or plastic let in sunlight, a natural disinfectant. Sliding doors sealed against wind, rain and insects lead outside. Plumbing, fire alarms and lighting fixtures are part of the infrastructure. Lights are soft white and light up the place thereby ruling out recessed ones with their lower illuminating capacity. People sometimes sleep with some gentle lighting on, insomnia in your society being largely from stress. They either use shades to cover eyes completely when sleeping or have beds in separate areas with screens or tents which block out light. Our biology needs this to produce some of the tumor-fighting melatonin hormone and to repair cells. Moderate sounds startle only a baby trained to sleep in perfectly quiet conditions and the same applies to adults. People sleep alone since it is more comfortable. Largely waking to the warmth of the sun and sleeping in its shadow. Table and ceiling fans, being dangerous, are not used. Attic fan, air cooler, wind tower and central air-conditioning get used, based on geography, to cool and circulate air.

No ownership has made security senseless. Bars, bolts, chains, grills, padlocks, shutters and strong doors have all gone. With security out of the way, hardened glass or transparent plastic is used extensively. Beams, trusses, girders and support structures are of steel. Light and strong. Iron, carbon and nickel to make it are plentiful.

Sinks, water taps and detachable hoses abound. And cloth rags and paper towels to mop up spilled stuff. Flooring is suited to the region—wood, vinyl, concrete or thin carpet—and easy to clean. There are sinks both inside and outside dwellings. Outside areas are cleaned with pressure washers and hoses connected to outlets with pressurized water. Taps with running water exist everywhere to allow women in their menses to clean up periodically.

Beds and furniture are spaced for people to walk through. Carvings, headboards and rocking chairs belong to the past. We apply paint, veneer, varnish and other finish only against rust and termites. We base furniture design on our anatomy. Seats are of adjustable height and supporting the spine and tables with adjustable-height legs, so kids and adults can use them together. Furniture is wheeled to move easily. Chairs and tables are of plastic, fiberglass, aluminum or other light metals. Heavy glass or wooden furniture is rare. Bookcases have vanished along with books. All information is now online and accessed through computer terminals. There is no almirah or cupboard. Relic, curio, painting, portrait and sculpture are considered useless.

Fire alarms exist along with extinguishers and a few outlets with high-pressure water. We allow for, but do not base plans on, emergencies. In an emergency people get out fast since they are not slowed by partition walls, personal items, or putting on clothes. Since we are able to sleep when sleepy, at all times there are people awake in or near every dwelling since the biological clock, though tied to the light-dark cycle, varies across persons. So a fire or other emergency is acted on promptly. We are now developing robots for such chores, surer and swifter sentinels. First-aid kits in dwellings help attending to cuts, wounds, aches and pains, accidental swallowing of poisons and similar situations requiring simple but urgent care.

We cook individual meals in kitchens close to dwellings. Such group kitchens have stove, utensil, implement and raw material to cook and eat, and precooked food. Refrigerators and deep freezes store food and perishable items. No individual or group owns items, all free. Volunteers restock food and clean premises. We are happy and therefore able and inclined to do such work. There are also group showers, restrooms (lavatories) and articles for basic hygiene—soap, towel, toothbrush, nail clipper, hair-cutter and so on—close to dwellings. Whoever needs the article uses it, cleans it, and puts it back. Items for personal hygiene are owned and used in common. Cleaning equipment is kept separate. Trash cans have been placed throughout buildings, kitchens, restrooms and outside. Some collect trash periodically in trucks and take it to recycling centers or dumps.

Energy is free. That includes petrol, diesel, cooking gas and electricity. With plenty of free taps and sockets in dwellings and elsewhere. Showers, kitchens, dwellings and other buildings also have plumbing with free water and communication facilities in the form of phone lines and fiber-optic lines. Some showers, restrooms and group kitchens have been built separate from dwellings. No person or group lives in any residence for long; people travel and tarry in whichever they choose.

11.3.2 What we wear

People wear clothes only as needed to protect against nature outside or as a safety measure for specific work. We own them jointly. Racks of clothes of different sizes and thicknesses are hung next to exit doors of dwellings, with washing equipment near by racks. If outside weather warrants it people put on the cloth of the right size and shape leaving the dwelling and place it back on the rack when entering. The color or kind does not matter. If a dress gets dirty the wearer drops it in a washer. The first to fill the washer soaps the socks, shirts, and skirts and starts the washer. When washing is done the next one around moves the bundle to a dryer. Afterward some volunteer gets them back on a rack. In summer clotheslines are used to dry in the sun.

Clothes are easy to move around in. It is easy to work, walk or run, sit or stand, and eat or drink, while wearing one. For women, they let menstrual blood be cleaned with water, with no blood sticking to the cloth or the body.

11.3.3 How we make food

Agriculture is considered crucial. Our people have insulated it from vagaries of nature using greenhouses, genetically modified plants and sophisticated irrigation. Food no longer depends on soil or climate anywhere. Free transport of goods also contributes to this. We have mechanized and automated farming with computer-driven tractors, robotics harvesters and threshers, and so on. Robots sow, plant, tend crops, and pick, pluck or reap fruits, cereals and vegetables. People remotely survey and direct them when needed; soil has germs we avoid. Tilling robots are unmanned tractors with controlling computer software, navigation systems, and sensors such as cameras and radars. Abundant material exists on earth to produce food for a population orders greater than the current number.

Hydroponic farms flourish since they permit plants in a three-dimensional space without soil. Plants need no gravity to grow and so these farms will eventually be built in outer space and on other planets. Solar energy will last us long and hydroponics converts this cleanly and conveniently to food.

11.3.4 How we communicate

Computer terminals are connected in a universal network and present everywhere free. No one feels tied to a specific computer —data get stored online with many distributed copies. Everyone has a unique ID (Identification) similar to a personal name in your societies. The main difference being the ID identifies someone and implies nothing social, cultural, emotional or psychological. These ID's will be unique forever with no two in different eras the same. Medical information has been put online. Nothing is encrypted or password protected. Search engines search the universal network to answer questions and lookup queries. Software and hardware are free with no ownership of computer terminal or communication tool. In the future the network will expand to every nook and corner of every spaceship, planet, star system and region of space we use.

Communication equipment is truly widespread. Computer terminals double as a voice and video tool. All vehicles and outdoor areas have such integrated systems. People carry portable terminals only out in the wilderness or in deserted regions. As with other equipment these also are owned in common.

11.3.5 Our way of work

Volunteers do not get tied to their job, nor is there a system to choose them. Now and then people look around, see what has to be done, and do it. Our population is large enough to stock and supply volunteers. Basic day-to-day activity gets automatically coordinated and not managed or organized.

There is no money, barter or pay for work. No wage, debit, credit, finance, trading, banking, lending, borrowing, economics, stock and bond, or economic planning. People do what they love to. For complex work they automatically team up with others with the same interest. If far apart the team coordinates through the universal network or travels to a place agreed on before.

The hysterical haste of deadlines, the stress and the bitter taste of missed schedules, does not exist. Everyone does things at their pace. Happy men and women work at a steady speed on things which interest them. When working in teams the same thing holds. Your deadlines, seldom met, were a by-product of the steady starch, spare sweets and the unspared rod nature of your work policy.

Automation with software has caught on. Seeding to sowing has been automated, beyond being mechanized. Factories run on automated software with volunteers monitoring online ready to intervene manually if required.

Volunteer teams do construction work. Some volunteer poking about discovers the need for a new plant to make goods, produce food, generate energy and so on. Such researchers then, physically or online, look for more volunteers. These teams always have a mix of expert and newcomer. The team stays together until the plant is built, with possible dropouts and new entrants. Once the work is done the group disbands. Blueprints, details of material and camera images of interior wiring and plumbing get recorded online so that later a different set can maintain the work. Original team members also stay around to answer questions if need be. A universal network with no privacy or security makes it straightforward to contact and communicate with anyone anywhere.

11.3.6 Moving around

Travel of varied kind is free. Driving has been made driverless with software. Your technology applied right would have been enough for that. People get on, indicate where to go, and hop off at the destination. Medium- and long-distance vehicles are equipped with a minifridge, raw and packed food, cooking utensils, a microwave oven and portable gas burners. They also have a bed, a portable toilet, a trash container, a small water tank, a small camping style shower, and water-inlet and sewage hookup. Along with a terminal connected to the universal network. Resources exist to build enough vehicles to ensure wait-free travel. Wind power, hydropower, solar power, tidal energy and geothermal energy meet this need.

We use many means of transport and different type of vehicles but they guarantee our biological wants while traveling. Specifically with basic food and drink, automatic driving, access to toilet and shower in the vehicle or along the road, and space inside to walk and lie down. Some vehicles allow multiple passengers, in which case people wait some time for them to fill before pushing off. They also pick up others headed the same way, along the road. Direct stopless travel is used sparingly for an emergency. With no schedule to worry about few need hurry to their destination.

Little reason exists to get to the opposite point on earth in a day. This was needed only in deadline-bound societies. In ours people move with intermediate stops avoiding both jetlag and frequent air travel. Since mode of life is similar everywhere and since nobody owns anything most travel is one-way. Lack of preferred dwelling or place means there is no reason to be back. There is no key, visa, money, ticket, luggage, passport, credit card, or packing and unpacking to worry about.

People avoid jetlag since a single hop across timezones is unusual. Most travel is overland one-way with stops at dwellings in-between. Automated vehicles, not owning any item, and being able to stay in touch with the universal network, combined make such journeys nondisruptive. Even for air travel across timezones jetlag is only a small issue. People are free to sleep when they want to and eat when hungry. Jetlag has biological effects but its misery in the past was sociological.

11.3.7 Carting things

Automated vehicles transport items such as goods, produce, grocery and raw material. We use freight vehicles only to transfer goods. These vehicles need just container space besides the engine. Automated software driving them turn or brake to avoid pedestrians and automobiles in its path. Volunteers load them and enter the destination address for the computer to route on its own, where other volunteers unload items using mechanized equipment.

11.3.8 Our common way of life

With free travel and a common way of life we have developed one language. The hybrid language borrowed words and grammar from diverse languages. Its vocabulary is minimal being rid of the concepts of art, economics, sociology, psychology and literature.

Free travel, wanderlust and curiosity ensure people grow up with no regional accent, culture, language, tradition and food liking. Adults have no home or homeland.

Natural disasters cause no heartburn because no one is attached to things or people. Nobody has friend, relative or property to lose and deaths do not upset the living. We still protect our lives best we can. If that effort fails in places some analyze and improve things rationally, say by proving a dwelling to be in a danger zone.

Plastics are convenient since they are light, strong, flexible, transparent and good thermal and electric insulators. They are now made from organic material like starch and hydrocarbons. In turn synthesized from methane, hydrogen and carbon monoxide using reactions such as the Fischer-Tropsch one. Sources mentioned in section 11.1.3 on page 232 feed energy for this process. Other sources have replaced hydrocarbon fuel which is now used only to produce tar, plastic, bitumen and such material. Even thermosetting plastics are recycled efficiently. Synthetic hydrocarbons can produce plastics for several centuries, beyond which we will discover new materials and energy sources. Technology advances rapidly in our society since all of us are involved with it. Hence our blueprints need stretch only a few centuries out.

There was never anything mythic or mystic about the womb; it is a physical entity like any other. We have replicated its conditions, and no woman gets pregnant any more. Men and women contribute sperm and eggs to fertility banks where they are mixed randomly to produce embryos. These are then gestated in incubators till a newborn is produced. No extraordinary effort is taken to preserve any embryo; the conditions of the incubators match those of the uterus. The population grows continuously as there is enough in resources to support us all.

Taking care of newborns is a group, societal responsibility. An infant needs milk, burping, holding, cleaning, patting to sleep, playing with adults, and monitoring for illness. These require no special training. All of us use technology to track illness, diaper change history, and feeding habits such as nipple type and normal amount to feed. This history, stored online, is got or updated from a computer terminal next to the crib or baby bed. There is always an adult to take care of a tiny tot; jobs are taken up voluntarily. Most babies are fine with basic care. Neonates, babies less than a month old, sleep half the time.

Sleeping people might not be aware of a small one next to them and hence a baby sleeps in its own crib right from birth. Pacifiers are out; we let infants suck their thumb. Infants need to be held and rocked at times but any grown-up could do it. Diapers are used to stay clean. Diaper change times get recorded so anybody can check and do it.

A small one learns observing adults do things. Most adults who come in contact with one speak to it some time or the other and play at least from sheer curiosity. He or she avoids needless cooing, cuddling and chatting, all of which train children to depend on adults more than they should. Such dependency might have been beneficial in your societies but at the cost of likely misery in the future. Infants need monitoring and a playmate when awake. With large groups in dwellings there is always somebody for these, day and night. So babies sleep and wake up when they feel like it. As they grow older the body clock naturally and automatically develops.

A baby's food depends on its age. We record this information and past illness, allergy, food habit and other facts relevant to care, online. Adults who see a small child cry look at the data to figure out what is wrong. They enter information on the care back in the system.

Infants sometime have to be hospitalized for a rare disability. Usually some adult recognizes this, directly observing it or scanning the online database, and acts. In a hospital voluntary doctors and nurses take care of an infant for as long as needed. Then it is discharged and taken to the nearest dwelling. Since women birth mostly in the early decades at an average of six to seven children, and since all of us are caregivers, the ratio of caregiver to infant is high. As our lifespan is going up, this ratio is slowly getting larger.

There are nurseries only at hospitals and infants grow up with adults in dwellings. Newborns respond positively to all others irrespective of who their biological parents are. A baby feels attached to the generic person and not to a set of people.

Children need help when they first get up and toddle. Grown-ups help them take their first step. Toddlers imitate adults to learn to walk. No dedicated person teaches a kid unless it is physically abnormal.

Adults are aware of kids and do not bump into them. In our relaxed society, time pressure absent, people can check what is in their way before going along it. A toddler coexists in a world with people of all ages.

Toddlers are unaware of pits, drops, trains and other physical danger, man-made or natural. Man-made hazards have been made off-limit to them with technology. Fences or entrances which block small kids protect them from rails and train stations. Cars, driven with automated software, detect children (and adults) on the road and steer clear. Small kids are protected from natural hazards. They can get to a pit, lake, pond or cliff only if an adult takes them there. Or fall down from a height only if somebody leaves them there. An adult who sees a tot near a dangerous area picks and puts it in a safer place.

Children learn language listening to others. Adults talk lucidly and rationally to young ones. Rationality is something kids understand. The universal language is easy to pick up with all irrational and meaningless words gone.

We train children to use a toilet since it is hygienic, and tell them why to avoid dirty or poisonous food. Being ourselves content makes us patient with kids, repeatedly stressing the same rational message. Kids ask questions we answer logically. Juvenile fiction, and other fiction, ceased to exist; kids are now brought up in the real world. The young play with everyday objects, and adults ensure such objects are safe to play with.

Toddlers scribble on things. Grown-ups let them do it unless scribbling makes the object unusable. A wall keeps out sun, wind, rain and the cold the same way with graffiti on it. The universal language has no word ‘esthetics’ as it is irrational.

Our dwellings are childproofed. Sockets and switches are well above toddlers’ reach. We tell them calmly and rationally why it is dangerous to play with certain things certain way. If told patiently and repeatedly, they understand reason for things when such reasons are clear, consistent and in line with basic wants. Every child feels comfortable with everyone. All are able to explain reasons for basic actions consistently to little ones.

Children have been shown good food habits. This does not mean meals at a specific time, but eating when hungry. You had fixed, forced mealtimes since that was socially convenient. We tell growing ones repeatedly why not to eat certain food to excess. Boys and girls eat the same thing men and women do. However that they are growing up and are smaller means the portion they need is different. This fact is logically explained to them. Acceptance based on reasoned thought prevents unhealthy eating habits later. No one eats to distract from stress. There is no stress. Marketing, time pressure and advertisement do not exist, freeing us from junk food. Adults develop normal food habits influencing the youth positively. Coupled with reasoned, unconflicting explanations, everyone automatically learns to eat right.

Teething is a natural part of growth. Toddlers are let free to bite, especially during this stage. Unsafe items are removed from their reach. Grown-ups stop them from biting people with calm, logical explanations reinforced by lightly showing how a bite hurts.

Education is limited to teaching to read and write the universal language. Kids become motivated to read seeing adults read. Adults and older preteens teach the language step by step unstructured and informal. Kids need help on how to search online, use a library, search a bookshelf, use a computer terminal, and read recorded information on chips, microfilms and bar-code scanners. They also need help learning to cook, and use a faucet, toilet, shower and automated vehicle. Teaching is unforced. Seeing people do these makes kids wonder how to do the same things.

Small ones also see adults work and travel which motivates them to do the same. From this point they are not tethered to a place. Youngsters move from region to region unattached to place, person or property. They grow up free.

The young, with developing immune systems, fall sick more often than adults and are assured such illness passes with time. Kids down with a fever might fear the condition lasting forever. Adults explain to them this is not so. On catching a flu the next time, they will remember the advice and the experience. Sick children are monitored frequently, just as babies, by recording online a history of symptom and treatment.

People show older, physically able, youngsters how to care for infants and toddlers. Youngsters take care of babies the way they see grown-ups do without being taught.

Sex being free maturity is not a turning point for a boy. Growth means change in ability, free of turbulence that marked puberty in your time. Turbulence caused by sexual frustration. Other's frustration affected you earlier but at that point, in your societies, there was a direct repercussion as well.

No age, thirteen or eighteen or twenty one, is sacrosanct to us. Our physical and cognitive abilities decline with age (our sensory organs gracefully degrade) and this fact bothers none. There is no rule or regulation to enforce a duty to society. Our wants are met free and we automatically help others.

The elderly live with everybody else, except the infirm who have to be hospitalized. Robots, automated wheelchairs, and other automated equipment help them feed, walk, communicate and clean themselves. Healthy adults help with their chores. Ailments which crop up in old age from a lifetime of sedentary living have vanished.

Death is nothing sacred or special. We prolong life utmost, but all have the right to die though none want to. We autopsy bodies to further medicine. Corpses become food or fertilizer based on meat left and the cause of death. All meat is pressure cooked to kill germs including prions.

No personal attachment ensures no grief over death. Records of the dead are preserved. Technological progress keeps pace with our recording storage need.

None of us have psychological illnesses except from physical brain defects or injuries. The rest was the product of abnormal societies unknowingly worsened by psychiatrists and psychologists. People sometimes have biological defects since our medicine is not yet at the stage where it can eliminate all of these. Such people, few as they are, have basic necessities of life—sex, food, drinks, help with daily chores—free. Volunteer women offer them sex, an activity usual for women. In our cooperative society disabilities do not bother people. Handicapped people who still communicate ask for and get help. The rest are monitored by volunteers and increasingly by robots programmed to look for signs of distress and provide daily chores like bathing and feeding.

Injury is rare as risky adventure and thrill-seeking vanished a while ago. People climb mountains only for a reason, say to map the geography or to look for some resource. Nobody is injured from horseback riding, there being no reason to ride anymore. Individuals and groups still explore new territory cautious and well-prepared. There is no theme park, bull fight, camel ride, rock climbing, roller coaster or a dangerous pet including a cat or a dog. Everyone keeps away from animals except to research them, and there is no circus or circus animal. Competitive sport or game, or a sport with risk of injury, no longer attracts anyone.

Hospitals exist. Medical facilities contain isolation rooms for airborne, communicable diseases with high fatality rate. Hospitals have kitchen and cafeteria with food. Nurses and doctors are volunteers who self-studied medical topics of interest to them. Their pills and potions aided by medical diagnostic software.

11.4 Where we changed

Sex when men want it is where we differ the most from the past. Since to copulate when required is a male want only females can satisfy, the social guarantee is defined precisely. It is meeting men's need to mate anytime, anywhere, with any woman. A woman can be indisposed only if she is eating, drinking, sleeping, urinating, defecating, not yet at puberty or physically ill or injured. For the first five cases a guy waits a reasonable period till she is done. A tired and resting female is still available since sex requires little from her. Men should not, and in our world do not, inflict physical pain or discomfort their partner. Straight vaginal intercourse, gratifying for males, is painless.

Discussing positions has ceased in our world—one comfortable to both works. Such can be found in any physical setting. Men feel weak for a moment after they come. Women have no urge to thrust and men like to thrust straight or down, not up. Our positions account for these. Anal sex is torture. Oral and other such are poor substitutes. These inclinations have disappeared with free sex. Male masturbation is an emergency measure used, for example, by marooned ones with no female company. Female masturbation substitutes for pleasure from intercourse and ejaculation.

Everything free is the second most important concept we have and you rejected. Absence of money and barter has ended competition and erased anxiety. We have become productive with wants met. Keeping people happy and improving the quality of life with regards to shelter from nature, catering to our wanderlust, satisfying biological wants and preventing and curing illness being the measure of productivity. Your idea of forcing people to work by tying want to labor was dangerous. Curiosity and the urge to cooperate make us work efficiently. Being satisfied ourselves, none of us bother to measure and compare productivity.

Our sexes differ in menstruation, the sex act, and in other minor anatomical ways. We have no gender identities beyond these. People of both sexes work in all fields, following their individual aptitude. We do not tie biological sex to any particular way of doing things or liking things. Hence we have no gender identity issues. There is no socially constructed gender role. Nor do we have gender-specific clothes, since we use them only as a covering against the climate or to protect from injury, when outside.

11.5 Our psychology

Full flow of free will means we behave statistically no more. To meet our wants all of us cooperate with one another leading to far fewer troubles than in any other kind of society. Shortages are gone, mental disease, except from physical brain defects, disappeared and irrational belief vanished. Nobody worries about equality. Technological progress does not cause us to fret about the future or send tremors through society. We are today part of society while you were its prey.

Love, race, clan, class, rudeness, politeness, tradition, ethnicity, cultural root, hospitality, nationality, linguistic affiliation, psychological or social component to biological relationship and attachment to place, person and property, all vanished. People have no son, spouse, father, mother, sister, brother, in-law, cousin, daughter, grandkid or grandparent in any but the strict biological sense of the term. Morality, ethics, duties and liberties have become irrelevant. Friendship exists only as team work. Emotional attachment has become a thing of the past. This ensures no one is sad when things are lost or people die. Mosques, temples, torture, crusades, churches, stampedes, pagodas, religion, synagogues, abduction, kidnapping, paranoia, sacrifice, pilgrimages and stranger anxiety have been consigned to an unfortunate history.

Stress has ended and worry about the future is gone. None of us have imposed schedules to meet and are concerned about job security. There is no hall of fame or shame. We stay away from ranking individual effort or rewarding those at the top. Theft, fights, poverty, malnutrition and competitiveness are all equally meaningless words to us. Humans refrains from violence against others for it is needless. Violence brings no real pleasure.

We will build further on true science, medicine and engineering. And eradicate disease from germs and live to our full life span. Based on average DNA loss in genes this is close to one hundred and twenty years.

We see this report as one repeating self-evident facts.

11.6 Our technology

Technology is neutral. It is deployed wisely. As an example, to record growth history for medical purposes. Technology is used to move things around, to cure illnesses and heal injuries, to communicate, and to exploit resources. We will need to expand to other planets, star systems, galaxies and superclusters. We plan to employ terraforming and vacuum energy to this end. Our medicine includes anesthesia, antibiotics, emergency care with invasive surgery, and such uninvasive diagnosis techniques as X rays and MRI scans. Better communication includes permanent online addresses where a person can always be reached. Records are open and public. The term ‘password’ has vanished. Data is often compressed but never encrypted.

We build the most powerful robots we can for these purposes, applying robotic software to safe, driverless vehicles and automated farm equipment. And to medical diagnosis based on huge databases of prior illness of all, autopsy reports which indicate cause of death, and other medically relevant information.

Technology gets used only if needed. Power to change our genes is an example. Gene changes are based on how they improve us. The first step in your worlds was to understand how much genetic and how much social your problems were. We fix genes to remove rare growth defects but not to modify our sex drive leaving us gender neutral.

11.7 Our sciences

Those who like it, when they feel curious, pursue science and contribute to research. Replicating experiments, and peer ratings, help filter the data into established and provisional. We have journals which collect articles, manned by volunteer editors, reviewers and contributors. Access is free. The physical sciences largely carried on from the contributions of the past. Both need and curiosity drive science, with some driven by the first and others by the second. All scientific records, including those of individual experiments, are stored online, readable universally.

The social sciences no longer focus on dividing people into groups: two, three or fifty-plus, and analyzing traits of each group. Such divisions are statistically useless in our world. We study the past to understand what we are building on. Our genetics is based on individuals, analyzing people's genomes to fix clear defects or for preventive medicine or diets.

11.8 The way we talk

We interact several ways. Informal, unstructured education is one. One-on-one meeting also contributes to learning. Meetings are physical or virtual, online interaction. People, on their own, still work to utilize resources and record what they do. Curiosity leads to continual travel, reading and interacting with others.

We avoid gestures, body language and facial expressions. They are vague and easily misinterpreted. Sign language works in a noisy environment or at a distance within line of sight. Technological advance might make thought broadcasting possible. This would be no big deal since no one lies or cheats or hides things.

Being dishonest is needless and useless.

11.9 Where we are headed

Our progress cannot be predicted. However our biology dictates some realities.

In the ideal world, natural selection will continue but only in its basic, purest form. Only those gene changes which cause a person's reproductive fitness to increase will be passed on. Kinship selection and inclusive fitness, covered in section 9.1.7.1 on page 187, will not operate. This means any genetic traits our species inherited and maintained through complicated natural selection procedures will vanish in the ideal world. The details of evolution theory are, for the most part, immaterial to our vision.

Population will continuously double and effectively utilize resources and energy sources on earth. Next occupying neighboring planets and satellites, eventually settling nearby star systems and galaxies. Technology will progress to help all keep in touch with only short delays. The universal network will follow us. We will discover and use new energy sources. All of us will continue to have a uniform way and to each this much will be obvious: I am a person, a man or a woman, myself and nothing else.

12 Today's societies

I have relied heavily on evolutionary psychology's idea of adaptations to derive the nature of the ideal world. As noted earlier, the field has its critics. Much of its research is tentative. Its basic tenet, that our mind is made of many modules each coding for a trait, as opposed to being a general-purpose learning machine, is neither theoretically nor empirically established. The core of the science is not yet firm.

However, the other views in psychology are more fluid. Behaviorism states the mind is a learning machine, which can be taught with reward, punishment and reinforcement. This is closer to the blank slate argument. Religions also tend to prefer this view. If we truly are blank slates driven by learning and reasoning, the same argument holds. Rationally, sharing everything eliminates jealousy and possessiveness. I analyzed the sex want using anatomy and neurochemistry, not using EP. Rationally, based on the analysis, men need to mate free for wants to be satisfied. Sharing everything implies no money and no barter, and hence a way of volunteer work. Men mating free implies children have to be brought up in groups, since just the mother cannot manage. Since human newborns are more immature than those of other primates, larger groups are required to bring them up. Statistically, randomly mixing children and adults is the simplest, most efficient solution. Children left free will automatically move around and uniformly mix. But this means no formal schooling, since that ties a child to a place.

12.1 Social psychology

Elliot Aronson's *The Social Animal*, now in its tenth edition, is a standard text on social psychology. The prescribed one for the introductory course at Stanford, Aronson's alma mater. I will look at this field to see how the ideal world stacks against its ideas. The science does not allow us to derive the idea of an ideal world from its descriptions, since those explain our behavior in current societies. The focus is on proximate, immediate, causes for behavior as opposed to the EP focus on the ultimate causes. But it does help to show a transitional society moving from ours to the ideal one will progress one-way.

Aronson defines social psychology as the influences that people have upon the beliefs, feelings and behavior of others. This seems to define the environmental effects on how we behave, as defined by the behavioral genetics field. However, the effect is environmental only for those being influenced. Those doing the influencing would be driven partly by genetic wiring. Social psychology does not attempt to separate the two. It depends heavily on controlled experiments on volunteers for its results. Surveys have less value because people's answers do not always reflect their feelings or behavior.

The text ([4])divides the field into the broad classes of conformity, mass communication, social cognition, self justification and the theory of cognitive dissonance reduction, aggression, prejudice and liking or love.

12.1.1 Conformity

Conformity is people changing their behavior responding to real or imagined pressure from others. Subjects who resist such pressure show greater activity in the amygdala on FMRI scans, a region associated with pain and other emotions. People find it difficult to go against the group.

People find it harder to disagree with a unanimous decision by the rest, than one where there is at least one dissenter, even when the dissenter holds a third opinion. People who are already committed to a view find it easier to disagree with a group. Most people will go along to get along unless they know they will be held accountable for a dumb decision. Those with low self esteem yield more to group pressure. Cultures with collectivist societies, such as China, Japan and Norway have more conforming people than individualistic societies such as the US and France. A group is better at pressure if its members are experts, high in social status, or peers.

Why do people conform? As noted, some go along to get along. Sometimes we look at how a group behaves to decide how we should behave, especially in a setting where we are not sure of the manners.

Even our emotions may track those of other people, even when we are not directly dealing with them. In one experiment, some subjects were given epinephrine, which raises activity levels, but were told it was a vitamin supplement. A stooge was planted who received a placebo injection. As the shots took effect (in others), the stooge expressed euphoric emotions in one case and rage in another. Many participants, in both cases, reported the same feelings as the stooge when their heartbeat rose and hands began to tremble from the shot. When experiencing a strong physiological response for no clear reason, people decided to feel (subconsciously) whatever others in the group felt.

People get influenced at three levels. **Compliance**, or obedience, is motivated by wanting a reward or fearing being punished. The influencer's power matters. **Identification** comes from wanting to be like the influencer, the role model effect. The influencer's attractiveness decides things. **Internalization** is the strongest and longest lasting, and it comes from a desire to be right. The influencer's credibility plays the largest role.

Conformity is negative in the short-term in some cases. Apart from destroying creativity. The **bystander effect** is where a group of people refuse to help somebody they see in need of help, because they believe somebody else will provide the aid, there being so many people around. Medium term negative effects are legion. Aronson's points out groupthink as contributing to Hitler's rampage, Nixon's style, and the Challenger shuttle explosion.

For the ideal world conformity is neutral. Reward and punishment will not exist. Role models may. Credibility will. The costs of helping somebody would be nil, unlike now. The bystander effect is bolstered by the thought of lost time and fear of strangers. Authority, in the sense of cops and governments, will not exist, removing one major source of pressure to conform. No laws and no social rules remove two other sources.

12.1.2 Mass communication

The media, especially television, affects us. They determine what news gets to us, among the billions of events which take place daily. Selective emphasis gives the media power to influence subsequent events. How effective propaganda or mass persuasion is depends on who is doing the talking, how he or she says it, and to whom the message is addressed.

12.1.2.1 The source of the communication

Those who are experts and trustworthy are more credible. Credibility counts. Trust can be increased if the audience believes the person is selling an idea which is against his or her self interest. It is also increased if the audience is convinced the person is not trying to influence them. At least for trivial opinions, if we like and can identify with a person, we will be influenced more. Even when we know the person has an agenda.

12.1.2.2 The nature of the communication

All other things being equal, ceteris paribus, an emotional message carries more weight than a rational one. Frightening a person into taking preventive action works, but those with low self-esteem might be too overwhelmed by fear to act. If accompanied by specific instructions on what to do, such messages can get past the denial. Clear, vivid examples are better than statistical data. When talking to those who lean toward a position, it is best to skip the opposing views, but when talking to a neutral audience, addressing objections carries more weight.

Consider a debate. Who has more effect—the one who speaks first or the one who speaks last? The first impression effect, which could bias people at the outset, is called the **primacy effect**, and the last word, which might be what people remember the best, the **recency effect**. If there is a large interval between the first and second arguments, the recency effect dominates, and it is better to speak last. If not, mostly it is better to speak first, since the recency effect fades over time.

If what you are saying differs strongly from what the audience believes, you need to be highly credible. If your credibility is only slim, you can hope for maximum opinion change with moderate discrepancy between your message and the audience's beliefs.

12.1.2.3 Characteristics of the audience

It is easier to persuade people who feel inadequate. Audiences are more receptive when they are well fed, relaxed and happy. Forewarning them they are going to be subject to persuasion makes them less receptive. People tend to invent objections on the spot to messages they disagree with. To block this, distracting the audience while the message is being delivered, helps. If an audience is presented with a diluted version of the objections, along with an analysis of why they are wrong, they will be less influenced by a later presentation of the full set of objections. This is the inoculation effect.

12.1.2.4 The principles

These ideas are supported by a wealth of data from controlled experiments carried out by social psychologists. From our viewpoint, the data are neutral. Methods of influencing audiences might be of use in carrying the message of the ideal world across, but they do not matter to the philosophy. They neither preclude nor support any particular social system.

12.1.3 Social cognition

The world bombards us with facts. No one can absorb all facts, reason, and then act. We all need to filter what we are going to go pay attention to. We all need to use rules of thumb, **heuristics** to select.

To avoid constant thrashing, once we pick the first few facts and form an idea, we bias our filter to let in more facts in tune with that idea. This is the **confirmation bias**, seeking confirmation of first impressions. Human cognition, in psychology's jargon, is **conservative**. We maintain preexisting knowledge, beliefs and biases. We preserve such biases by using still another one, the **hindsight bias**, which strengthens what we believe. This bias is the familiar "I knew it all along" belief most of us have after knowing the results. Cognitive stability comes with a price. We fail to update our ideas in line with reality, when the reality changes fast. This could lead us to see events in a distorted way.

The judgmental heuristics we use, the mental shortcuts, are many. In the **representative heuristic** we extrapolate from a similar object. **Stereotyping** comes under this. In a more extreme form, this leads to racism, in-group favoritism, and the **homogeneity effect** where the outgroup members are thought to be similar to one another and differ from our ingroup members. In the **availability heuristic**, we check how quickly and easily we can remember an example which supports a belief, to see if the belief is likely right. For example, if asked whether more people die in the US from shark attacks or falling airplane parts, most would say from sharks. We can bring an example of some news item for a shark attack, or at least the scene from Jaws, to mind. Few would be able to remember any report of anybody dying from a falling airplane part. Aronson claims the answer is wrong, and reflects the media covering rare sensational events more.

The **attitude heuristic** extrapolates from our attitude toward an object to everything associated with the object. If my attitude is one of being hostile to the Republicans, I would automatically assume, at first glance, a complicated 500-page proposal on healthcare from Enzi is not credible. The **halo effect** is another version of this. We also overestimate the number of people who agree with us on any issue, the false-consensus effect. We believe others like and act similarly to us.

Our memory of events is not a replica of the physical past. It gets refreshed by a reconstructive process, modified by ideas of what should have been, and what others tell us did happen. Suggestive questioning can influence memory. We also tend to organize memory in **self-schemas**, coherent feelings and beliefs which form an integrated whole. Since in the real world our actions may not have been that way, we distort the past to fit the schema. It is easy to plant false memories of childhood, for example.

Our beliefs and attitudes thus influence how we think and what we remember. Attitudes do not always predict behavior, though. **Attitude accessibility** refers to the strength of the association between an object and our evaluation of it. Strongly accessible attitudes influence behavior. Beliefs can also influence us by creating the social world around us. We mix with others who have similar beliefs.

We have three general biases affecting our outlook. The **fundamental attribution error** is where we tend to believe people are driven more by their personality than the pressures of a specific situation. Most people have diverse personalities which crop up in response to the environment. The **actor-observer bias** is where we (the actors) believe we act driven by the situation, whereas others (observers) act driven mostly by their personalities. This may be because the actor's attention is focused on the environment whereas the observer's attention is on the actor.Then there are the two major **self-biases**: **egocentric thought** and the **self-serving**

bias. In the first, people see themselves are more central to events than they really are, believing others pay more attention to them than is the case. The second refers to how we tend to believe our successes are from our personal traits (**dispositional attribution**) while we fail because of things around us (the **situational attribution**). Psychologists consider this ego-defensive behavior, maintaining our self-concepts and self-esteem. It prevents losing from psychologically devastating us.

12.1.4 Self justification

People try to justify their own actions and attitudes. We convince ourselves what we did was logical and reasonable. This is the concept of self justification. From it comes the theory of **cognitive dissonance**. If we wind up doing something against our beliefs, we end up holding simultaneously two cognitions that are inconsistent. We try to reduce cognitive dissonance by changing one or the other view, or seeking out other information to bridge the gap. We will distort the objective world to reduce our conflict. A smoker, for example, who finds it hard to kick the habit for physiological reasons, may, on reading an article on its dangers, question how credible the facts are. With little justification other than a psychological need to rationalize one's own action. This ego-defensive behavior, since it helps us maintain a positive image of ourselves.

Those in committed relationships see opposite sex people as less physically and sexually attractive than those floating. Countering this, EP says this mechanism goes only so far, and if the alternative is accessible, it fails. The rate of divorce in cultures which do not stigmatize it supports the EP position.

People tend to focus on the positives of their choices, and to downplay unchosen alternatives. A decision that cannot be changed strengthens this behavior. In addition, when a person commits in a small way, they are likely to commit further in that direction, the **foot-in-the-door technique**. Those who behave immorally weaken their moral belief to be consistent in attitude. Those who behave morally when tempted strengthen their morality. As a result, the people who crack down the hardest on deviation are the ones who have been sorely tempted but resisted.

We justify behavior two ways. Where the behavior is rewarded or punished, we see our action as driven by that. This is **external**

justification. Where this is negligible, we use **internal justification**, changing our attitudes or beliefs, or even how we interpret reality. As a result, to produce change one should use weak rewards or punishments, get the person to do something and let self justification take over. Similarly, a goal toward which one had to work hard is more internally rewarding, because a person tries to justify the effort by inflating the value of the achievement. This is **justification of effort**. A person who has to be cruel to another because of various reasons will justify the cruelty by derogating the victim. Mentally forcing oneself to believe the victim deserved it. People also tend to make the best of something they know is bound to happen. Neuroscientists have shown cognitive dissonance is unpleasant and restoring consonance brings pleasure to the emotional centers of the brain (at least they light up in an FMRI scan).

Dissonance reduction stops us learning from our mistakes. It is often defensive and sometimes defeatist and dangerous. People do get around it by developing enough ego strength, and realizing performing stupid acts does not make one irrevocably stupid. Believing in how malleable our nature is helps get beyond this, more than believing our behavior is driven fully innately.

12.1.4.1 Our take

As the examples in Aronson's book show, our social cognition biases and techniques flower in the competitive environment of our current worlds. In any world people will still use heuristics to judge between alternatives. However, where being stupid does not block one from getting one's wants filled, and being bright does not get one more items and more access, self justification will be weaker. Self esteem is important where one has to compete and win to get one's daily bread. Dissonance arises because our morality is against our biology, causing us to be biologically driven to break its rules. Building a society where such dissonance is less is ideal.

12.1.5 Aggression

Social psychologists define aggressive action as behavior intended to cause physical or psychological pain. This is different from the usual use of the word to include highly competitive behavior. **Hostile aggression** stems from anger and inflicts pain or injury. **In-**

strumental aggression is planned as a means to a goal. Freud believed in a hydraulic theory that aggression was an instinct or energy, which if repressed could burst out. It had to be sublimated or turned into something useful. Studies among other animals indicate this is not so. Aggression is an optional strategy. Here social psychology tends toward the EP view that aggression is determined by the animal's previous social experiences, such as by the specific social context in which the animal finds itself. This is the processing model of EP adaptations. Catharsis, the release of energy, does not work. Venting anger, directly or indirectly, verbally or physically, does not reduce hostility. Aggression feeds on itself, because the pain we receive is felt more strongly than the pain we inflict. When we think we have gotten even, the other party is less likely to think so.

Aggression has many immediate causes in our worlds. Let us look at them next.

12.1.5.1 Testosterone

Testosterone is correlated to aggression. Higher levels increase aggression, and more aggression leads to higher levels. Men are physically more aggressive than women. But women engage more in social aggression in the form of excluding people, spreading rumous and gossiping maliciously. This is called **relational aggression**. Both biology and culture play a role in this gender difference.

12.1.5.2 Alcohol

Most, 75%, of people arrested for felonies are legally drunk at the time of the arrest. This could be because being drunk makes one more violent, or because more violent people drink more, or because the same drive that makes one more violent drives one to drink more. Alcohol disinhibits us, and disrupts the way we process information. That alcohol makes violent people even more so does seem likely.

12.1.5.3 Pain and discomfort

People feeling pain or discomfort are more likely to be violent. Animals which experience pain, and are stopped from fleeing, almost always attack. Step on a cat's tail, and it will bite. Other forms of bodily discomfort, such as heat, humidity, air pollution and offensive odors, might lower the threshold for aggressive behavior. The dog days of summer do exist.

12.1.5.4 Frustration

Frustration leads to violence. Being thwarted makes us destructive. More than actual deprivation, **relative deprivation** matters. Those who see others doing better, and they not being able to because the system is unfair, feel the most frustrated and are more prone to be violent. Hope that is unsatisfied thus leads to aggressive behavior.

12.1.5.5 Rejection and taunting

Bullying leads to upset people. Rejects are more intensely hostile. An atmosphere where one is excluded, rejected, taunted or humiliated makes us violent. This is seen most clearly in school settings, where walking away is not an option.

12.1.5.6 The mass media and social learning

Social learning decides whether a person is aggressive in a given situation. When the region of a monkey's brain that usually produces aggressive behavior, the amygdala, is stimulated, the monkey will not aggress if near another monkey it has learned to fear. We are less likely to retaliate if we hear a good excuse for bad behavior toward us, before it occurs. The presence of an aggressive stimulus, say a rifle left lying around, can prime us and make us tend to aggress more. Those who can stay anonymous or unidentifiable aggress more. Anonymity induces **deindividuation**, a state of lessened self-awareness, less concern for what others think, and weaker conformity to social rules.

Seeing a person be aggressive impels us to follow suit. This is where the media's role gets to be important. The most pervasive form, television shows, make us tend to be more violent by 1. Weakening previous inhibitions, 2. Triggering imitation 3. Priming us to be angry more often, 4. Reducing the horror we feel at somebody being violent, the **numbing effect**.

12.1.5.7 Political aggression

Aggression is sometimes used to attract social attention. It has been used as a dramatic way for oppressed minorities to shake up the majority, for example. But violence breeds violence not just by people retaliating, but also by aggressors trying to justify their violent acts post-facto by exaggerating the evil they see in their enemies. Increasing the chances they will attack again. There will never be a war to end all wars.

12.1.5.8 Reducing violence

The effective ways to reduce violence in our societies are:

- Reasoning, telling people the drawbacks of violence. Since aggressive behavior first occurs and develops in childhood before reasoning does, this is of limited use.
- Punishing violence. Severe punishment however results only in compliance, not internalization, as defined before.
- Punishing people to serve as a model to deter others from following suit. Research shows a violent person getting rewarded increases aggressive behavior in the viewers, but a violent person getting punished does not decrease aggressive behavior in the spectators.
- Rewarding alternative, non violent, behavior.
- Highlighting nonaggressive models, such as non violent action heroes.
- Building empathy, a feel for what the victim goes through.

12.1.6 Prejudice

Aronson defines **prejudice** as being negative toward an identifiable group using wrong or incomplete data to generalize. It includes three tendencies—to stereotype, to passively dislike or actively be hostile, and to discriminate. The first is thought-related, the second emotional, and the third behavioral. People are smug about other's prejudices they don't share; most find it hard to see their own. Those reared in a prejudiced society causally accept the biases. Subtle racism is strengthened by selectively rationalizing, say by focusing on people of that race who fail at a task. Sexism is somewhat different in that it could be the obvious **hostile** kind, or **benevolent** and condescending.

To **stereotype** is to assign identical properties to a group, ignoring how people differ within groups. Our brains are wired to categorize people automatically, unconsciously and immediately. This is from EP. The categories themselves clearly depend on societies. In ours, sex, race and age are examples. When not enough data are available to decide how to interact with a person, people use their first-cut prejudices, the stereotypes, to drive the talk. This is called the **the ultimate attribution error**. People use their experiences in interacting with others to calibrate their stereotypes, but we are biased toward trying to prove our prejudices are true. Given a choice between changing our minds and proving there is no need to so, yes, we do get busy on the proof.

Members of sterotyped groups, when primed to identify with that group, tend to fail stereotypically, being anxious about the stereotype. This is called the stereotype threat. People who believe the world is a just place, the optimists, tend to be more negative toward the poor, for example. This logically follows from their belief. For the world to be just and the poor to exist, there must be something wrong the poor have got to be doing. This **blaming the victim** is often coupled with hindsight bias to show what the victim has done wrong in the past.

Prejudice can result from economic competition. Once people feel hostile, eliminating the competition will not remove their emotion. Prejudices are also tied to **scapegoating**, from the ancient Jewish custom of symbolically transferring a populace's sins to a sacrificial goat so that their sins die with it. Scapegoats are mostly groups disliked, visible, and weak. Our need to justify how we behave strengthens our negative beliefs about other groups. Several studies show people with low self-esteem, or low or sinking social status, are more prejudiced. People who are authoritarian, that is rigid in believing, with conventional values, intolerant of the weak, and punishing in nature, respecting authority, are more prejudiced toward the non mainstream.

Reducing prejudice by forcing mixing works only if the mixing is of equal status nature. If the groups are still competing at the same time, especially economically, desegregation will fail. Forcing people to believe mixing and living equally with other races is going to happen whether they like it or not, the psychology of **inevitability**, does get them to start to accept other groups.

Aronson's one great contribution to solving a real-world problem has been the **jigsaw technique**, where children of different groups had to work together to solve problems the way a distributed jigsaw puzzle is solved. By cooperating and distributing partial solutions among one another. As opposed to the competitive nature of the standard school system. Aronson showed the jigsaw method reduced prejudice; in the case of this country, biases along racial and ethnic divides (p. 351). He believes the direct reason was **empathy**, experiencing what others feel.

All this sounds abstract, since I avoided examples. Most examples of prejudice from the social psychology field in this country refer to racial and ethnic biases. The controversies of racial prejudice do not interest us, since removing races, all races, by mixing, is how we solve the problem. One way to stop people from grouping others is not to have identifiable groups. Reproductive mixing and growing up in multiple places across the world will stop people from splitting up into distinct groups, or having distinct group identities.

12.1.7 Liking and love

We like those with similar beliefs and interests, who are able, skilled or competent, pleasant, having qualities like being loyal, reasonable, honest, and kind, and, finally, those who like us in return. We like those who do us unconditional favors. We are all deeply concerned with being liked and impressing others we are good in some sense. To sum up, we like others who behave in such a way as to reward us maximally, costing us the least.

People who evaluate others objectively negatively are appreciated by third parties, but not by the evaluated. Getting somebody to do you a favor makes them like you. This comes from the person justifying behavior by concluding the recipient deserved the help. The **pratfall effect** is where a highly competent person making a small mistake makes him or her better liked. Liking is also related to self esteem. A person who is continuously positive toward another has less impact than one who increases his rewarding behavior or switches from negative to positive behavior. Similarly, we are more affected when somebody who was positive to us turns negative, than when somebody is continuously negative. This is the **gain-loss effect**.

Beautiful people are judged more leniently in social situations, but not in serious legal situations. Men dislike it more when beautiful women evaluate them negatively, than when homely ones do. The pro-beauty bias begins at an early age. The liking for face and body symmetry, technically the absence of fluctuating asymmetry, seems hardwired since newborns attend to symmetrical faces more. The cycle of liking is self-feeding since attractive people are treated better, and in time they come to think of themselves as lovable.

People love the same way they like one another. **Proximity**, being in a nearby home, or studying or working at the same college, store, office or factory, or cave, decide the ones we likely love. Some psychologists divide love into **passionate love**, which takes us rapidly and is intense, but cools over time, and **companionate love**, milder, stabler, warmer and deepening over time. Being passionate, intimate and committed help with love. This **triangle of love** can be thought its basic structure. Passionate love is an altered state of awareness, similar to alcohol or drugs.

As noted earlier, we value rising positive feedback over a constant positive one. In a committed relationship, partners could hit the ceiling on positive behavior, making them value each other's behavior less. But a decrease in positivity would still hurt us. We will be influenced more by others being nice with us, but hurt more by our mate being rude to us. You always hurt the one you love. We do try to stabilize relationships mostly by not responding in kind. While openness in long-term relationships helps, balanced against it is the general sense being open makes others see where we are vulnerable, and in our competitive societies, exploit it.

12.1.8 The EP analogy

Every trait social psychologists have found has to be evolutionarily meaningful, and has to be tied to an EP adaptation or be a byproduct of one. For most traits, the jury is still out. It is unclear whether the EP adaptations directly code for the traits, or the adaptations are for subtraits which, combined, lead to the various behaviorisms described above. To us, that debate is moot. The adaptations are best left dormant. The ones which succeed at what they seek to do, such as aggression, succeed at others' expense. The other adaptations are only weakly effective, such as downplaying the attractiveness of other females when committed to one woman. Distorting reality rarely works for long—as we have already seen, objective criteria such as indices of health exist which can be used to measure beauty. The Coolidge effect also has no counterbalancing adaptation.

If these adaptations, if they are indeed such, are not to be used, one needs to be sure their inputs do not occur, and their calibration is deadened in childhood. The inputs for either pretending to be proud or humble, the self-justification and self-esteem related adaptations, would be the social need to evaluate oneself against others. This social need flows from competition. The adaptations related to the principles of conformity, mass communication and social cognition are neutral; they do not block sharing and free fulfilling of wants. Aggression and the liking/love adaptations I already covered in detail. Prejudice is a specific case of the preference adaptation already covered.

12.2 All roads lead here

In the end, we are again left with a society where everything is shared, men mate free, children are looked after by all adults, work is volunteer based, and there are no bars or costs to travel, communication and accessing or using information.

13 Economics of productivity

Economics: the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses.

Lionel Robbins

The latest economic model, capitalism with some state control and investment, has unleashed our talent and capabilities to a degree unknown in the past. Even one of its harsh critics, Karl Marx, considered capitalism the most advanced, progressive economic system the world had ever seen, considering its harnessing of productivity a must before a communist revolution could take place. Giving up on competition and letting people do what they want might get us a world of idlers producing some useful stuff and lots of junk, since work will not be driven by demand via the profit motive. Letting kids study what they want can lead to most knowing the basics of the sciences but few specialists who can actually research, design and engineer products. To be a doctor one needs about two decades of study, the second one specialized in biology and medicine. A researcher with a doctorate goes through a similarly long training. On the business front, complex products are designed by people with many years of experience working on similar, previous generation products. It is true that only about 10% of the population is at present productive, but there are signs that is changing. Extending the capitalist way worldwide will also lessen national rivalries and promote free movement. The entire world becoming economically like America is the alternative most, at least in this country, believe in and expect to happen.

That Thomas Alva Edison had no degree can be considered a special case. That the special theory of relativity was worked out in a patent clerk's office can also be thought an aberration, since Einstein was a trained physicist. But these examples illustrate a trend. The farther back in time we go, the more non-specialists have contributed in quality and quantity. Specialization has become more important over the years either because the subjects have become more complex or because we like to see predictable outcomes, even at the cost of sacrificing some innovation. Companies cannot be run at the whim of geniuses; there is a low probability they will succeed fantastically and a high one they will fail. A physicist trained for two decades can be expected to maintain on average a steady output in research. Even if we lose some rare innovators to the tedium of rigid training, the overall gradual predictable growth in scientific knowledge is considered preferable.

How does this stack against the ideal world, where we are left free to follow our aptitude? Does the lack of stress, from guaranteed wants and unforced study and work, outweigh the extra time spent on a forced curriculum or work environment? Clearly, with no stress, we will focus better and be more efficient during the time we do work or study. The question is whether the fewer hours we spend on such activity make up for the extra forced hours of today.

How are we forced to work today? By a mix of things. Tying wants to work. Instilling a sense of pride in work, the product and the company. Being taught the idea of achievement and competition, and the need to win. We work for our good, the company's good, and the country's good.

On the study front the enforced hours are direct. The only reason given is that a good specialized education is required to succeed as an adult.

One gets the answer by seeing the time we are awake as the sum of the time we work on something or study something, and the time we spend lazing around, entertaining ourselves some way. In the ideal world the time on entertainment will fall drastically, since most of it is to distract us from stress. Our waking hours will be fewer by 2 or 3 hours. The net effect will be that our working hours will be almost the same. Used more efficiently.

The inventions which triggered the latest wave of science and technology did not come from a competitive setup. Curiosity drove the inventors. In our own time, open source software has produced quality software on which others have built. Pooling of effort is now applied to space exploration, launching satellites and space stations, technology such as nuclear fusion reactors, genetic research including linkage and association studies, large scale twin studies, longitudinal studies of developmental behavior, and astronomical observations. Competition, with its divided effort, seems to have hit its limits in researching the complex world.

13.1 Specialization and division of labor

Specialization in schooling and work is almost a given today. In the ideal world, specialization will still exist. It will not be based on a formal, structured program though. Our innate talents differ. Those with an aptitude for math may find themselves drawn to scientific research, and might pursue advanced reading and problem solving in those disciplines. Those with other talents might pursue other trades. Many will become jack-of-all-trades.

13.2 Wastage because of no cost to consume

Capitalism says if things are free, people will waste them. Having to pay forces one to marshall resources effectively.

This argument assumes the tendency to waste is innate and has to be balanced by penalizing wastage. Wastage is not seen much among other great apes. Both bonobos and chimpanzees take enough to eat, and do not randomly pile up fruits, eat some and discard the rest. This applies to their nesting habits too. [QUOTES FROM GOODALL AND KANO HERE].

When one goes past the abstract statement, and expand on the objection, its flaw becomes clear. In detail, wastage is related to resource we consume. As an example, the common resources we potentially can waste are food, water, electricity, natural gas, oil, electronic goods including computers kept on, and perishable items stocked up unnecessarily in refrigerators to avoid the inconvenience of further trips to a grocery store. The list cannot be exhaustive or even representative, but the outlines of the flaw in the objection become clear by analyzing this list.

Food, water, electricity, natural gas, oil, can all be wasted. However technology can be used to control wastage. Instead of depending on a penalty scheme, most businesses employ timer or motion based systems which turn electricity or water off automatically. Eat all you want buffets work well as a business model, meaning patrons rarely waste food though there is no penalty to doing so. Fire sales and garage sales give things almost free, and rarely do people grab stuff for no reason, even if it is small and can be stocked easily. Water is free in public places, and wastage is controlled with technology to automatically shut off taps. Where people do not own stuff privately, accumulating items would not be an issue. Where there are no private residences, and nobody stays in one place for any length of time, the question of stocking up stuff close to where you are, so it is easy to get at, does not arise.

13.3 Lack of profit motive

Another tenet of capitalism holds the the drive to make a profit, that is earn money, fuels productive effort.

Needs always fuel effort. The need not to feel bored included. That the money one is superior is an assumption. Catholic schools, non-profits, provide quality education. This is not just the subjective view of one of its products. [DIG UP REFERENCES HERE]. So do Catholic hospitals. Most universities, private and public, do not operate for profit.

13.4 Producing things not in demand

In a capitalist system, demand drives production. If a good or service is wanted, there will be entrepreneurs ready to make and sell it. If not, few would want to be in that business, since there would be little money to be made. This automatically provides a mechanism to ensure we produce what people want.

The central question is how to define wants. In many cases, marketing convinces customers the product is something they need, but presumably did not know they need. Wants, to a great extent, are created by changing perceptions. Advertising is a very large industry, and its role is to create new wants. Demand does drive production, but demand in turn is driven by consumer perception. If that part of capitalism which shapes consumer perception is included, the demand and production equation changes. Shaping consumer perception becomes the trigger for the perception, demand, production, more demand cycle. A capitalist system in equilibrium state produces what people are taught they need.

Needs have driven both production and invention well before there was a capitalist system. A populace's needs are, in general, the same as the individual needs, scaled to its size. Qualitatively, these needs stay the same across individuals, for the most part. Every person can be expected to work toward satisfying those needs. Thus, since wanderlust can be considered innate, one could expect most people to work toward developing better transport. The same holds for better communication, better computation, and better medicine.

Macroeconomic theory: expectations factor.

13.5 Laziness

The need to make money ensures people work. It forces us to sit, focus, and spend a set number of hours on a project.

Open source software and volunteer work go against this conclusion. We do not like to sit around and do nothing for hours. Since satisfying basic wants, eating, drinking, sex, and others, takes around two hours of waking time a day, and assuming around ten hours of sleep time, we still have around 12 hours left. Wanderlust might get us to move around, spending on average 2 hours on travel or just walking around, or playing. That still leaves 10 hours. The work day will be as long or longer than now, and will not have to be enforced. Reading, study, and reflection are also considered work in this context.

13.6 Cooperative competition

The need to be faster-to-market or better-than-the-rest drives business today.

In the ideal world, there will be different teams solving the same problem differently. There will be no secrecy or competitiveness, though, since there would be nothing to compete for. Some solutions may catch on, and others may not. This is not going to affect anybody's economic security. Marketing would exist in the sense of explaining a solution to people. Frustration from failure to market today stems mostly from its consequences.

13.7 Capitalist theory

Growth factors: short-term, medium-term, long-term Expectations Microeconomics: consumer confidence Central role of productivity

Evolutionary psychology sees morality, like all other social constructs, as having developed from the needs of ancestral societies, and driven by genetic makeup. Positive social traits, such as not killing one another except in planned warfare, are seen as adaptations which would have led to better survival and reproduction in the hunter gatherer days. Since this field sees our societies as flowing from our traits, as opposed to societies influencing our traits, its take on morality as biologically determined is not surprising. However, whether our societies are the only possible ones resulting from our basic micro traits, or whether alternatives are possible but not been explored, is something the science does not address. Evolutionary time lag, where an evolved trait is no longer a positive adaptation because of a change in the environment, is a consequence of the theory. However whether our morality is such a no-longer-positive adaptation ends up being a philosophical question rather than an evolutionary psychology one.

Evolutionary psychology uses the idea of reciprocal altruism and ESS to describe how morality arose. Particularly, caring behavior, and the tendency to detect and punish cheaters which leads to making rules. We behave cooperatively way because positive social behavior improved reproductive fitness in in the EEA, and evolved as an adaptation. Morality flows largely from this trait.

How exactly morals came to be is speculative in the EP field. The speculation goes something like this. Reciprocal altruism means helping others, or impressing others they have been helped, and expecting a benefit in return. This leads to faking both help and returning help. Which leads to adaptations for detecting such cheating. And adaptations for punishing cheaters. A sense of justice evolves to strengthen the motive to punish cheaters, since bringing cheaters down is advantageous to survival. Moral codes flow from this sense.

The ideal world does not go against standard moral precepts except for removing the limitations on sex. Private ownership, group child education, and our way of work have never been part of any moral system. No moral rules will have to be enforced since they will flow automatically in the absence of negative inputs.

14 The other objections

Several objections exist to our ideal world from both theoretical and practical points of view.

14.1 Men will dominate

Women would be exploited since they are physically weaker.

We all are intelligent enough to know a wronged group will trouble others—it will find ways to fight back. A system where a gender is victimized will be unstable, restless and unhappy. Bad for you, and more importantly, bad for me. In the ideal world, what is good for you and what is good for me will be the same, and so I will not want to exploit you. Something which will hold for every you and every me.

Also, by and large the stronger gender has protected the other since history began. Women have been harmed by men taking out their anger in ugly ways, either beating them or more subtly restricting their freedom to move, talk or even eat. But across regions and throughout time more men have toiled to feed, shelter and comfort daughters, sisters and partners who depended on them. In a free-sex society the two would live mostly the same, since irritation from frustration vanishes making men calmer.

The pygmy chimpanzee has free sex in the sense the female is totally promiscuous, but no male domination. The common chimpanzee has more controlled sex and male domination. Humans are different from chimpanzees, so this cannot be used to prove any model. But it can be used to disprove the widely-held belief letting men mate at will leads to exploitation of females. That is not a given in the animal world.

14.2 Childbearing is hard

Women lose with free sex because they will forever be engaged in it and will be repeatedly pregnant.

With the duty to bring children up equally shouldered by everyone, repeated pregnancy will be easier than it is today. Giving sex free will not take up much time either. Sex is a straight biological act between an aroused male and a female. It is a guy repeatedly thrusting an erect uncovered penis into a vagina till he comes. As such it takes little time. The number of sexually active men would be roughly a bit higher than that of receptive women, with puberty starting the receptive period. The rate would be a small multiple of what exists now. Male biology limits the rate, with actual time for each act being shorter. Diversity in partners will improve drastically.

There is some evidence that repeated mating with the same man improves chance of conception. Semen contains immunomodulatory factors which apparently induce female tolerance to male antigens. The active immune system has two parts: the cell-mediated system which attacks viruses and bacteria which get inside cells, and the humoral system which attacks foreign bodies outside cells. Seminal fluid increases humoral immunity and hence sperm retention on the next copulation by the same man (Handbook, p. 365). Evolutionary psychologists see this as an adaptation to promote fertility. From our point of view, with free sex, the same number of copulations would result in fewer conceptions.

Net time spent on sex, talking of it, reading of it, thinking of it, and watching it simulated would come down dramatically across the board. Pregnancy rates will go up but female biology will limit the rise. Women would be liberated from the class differences of money, beauty, skin tone and hair color. They would be able to work the way they feel, far freer, with same status as men.

Childbearing is harsh on mothers because they get pregnant late. Girls should first get pregnant when biologically ready for it. They do not have to be ready psychologically, socially or economically. If delivery is expected to harm a mother physically, the fetus will be aborted. Pregnant teens are medically more at risk for just one condition: pre-eclampsia. An ideal world would deal with this by placing the health of the mother above everything else and aborting when the condition is detected. Certain other groups too are more at risk for pre-eclampsia; we do not recommend their not getting pregnant. There is little reason to consider teen pregnancy any differently. The standard for abortion would not be whether delivery or pregnancy is life threatening, nor would it be whether parents are equipped to provide for the child. Health of the mother would be the overriding element.

All schooling and training in an ideal world should be informal leaving teenagers free to bear children at a younger age. Tears and stretches from the first delivery heal faster for a teen than for one in her twenties, with subsequent childbirth being easier. Women will mature later in the ideal world than in single-parent families of the industrial world, and the normal male sex drive is directed toward a sexually-mature woman. In an ideal world, this age of maturity may indeed be lower than the legal age of consent today; however, in a transitional world with its other fetters on women, it is a must to follow the law of the land not just for legal reasons, but also to ensure women trust us to build a fair and equal society. Pregnancy does come with its pleasure—pregnancy craving. A pregnant mother's need to eat for the developing fetus as well naturally boosts her appetite, an indulgence denied to others. A pleasure masked today by overused vitamin pills, and the need to slim down later to stay attractive.

14.2.1 Why women need an ideal world

Today's conventions torment both genders. I list below many day-to-day problems women face:

· Males need to pick females (in most cases, only one at a time) to be their sex partner. Since men select and stick to a partner for long periods, they categorize when looking to pair up. In many cases, based on appearance. Girls and women are forced to present their body in the most attractive light and to market themselves by waxing leg and underarm, using cosmetics despite side effects, and applying makeup in hot and humid weather. Botox paralyzes face muscles; breast implants can leak and create a dangerous mess. Liposuction can lead to complications. Waxing and plucking eyebrows are generally painful. Women now subject themselves to many inconveniences to appear the way men like them to be. In the ideal world women will have no need to attract men and hence can appear natural.

· To display their beauty they have to wear high-heeled footwear, push-up bras, tight clothes and other uncomfortable clothing. Most underwear, pants and jeans make it harder for them to pee, since they originally were men's wear. Tight jeans may show off the figure better, but increase the risk of yeast infections. Males have much less to bother about in dress and footwear.

· In all cultures primarily mothers have to bring kids up. They sacrifice sleep to breastfeed, and are denied normal rest for most of a baby's infancy. Being the main person in charge of bringing up a child is frustrating. To mask this we teach the maternal instinct and hold it up as a positive feminine quality.

- A mother feels more attached to kids because she brings them up. If her kids fail to give the expected emotional support, she gets disappointed. Attachment ties people both sides of the bond. Women get depressed more than men do because societies bring them up with stronger ties and a liking to own things.
- They too are unable to eat when hungry, sleep when sleepy, and drink when thirsty owing to work pressure or social rules. This applies more here as men expect them to be gentler and hide irritation.
- Being physically weaker a Jane Doe is universally victimized more commonly. To avoid this she is forced to be wary of others. There will be no violence in an ideal world since there would be no need to be violent and a love of it is not inborn.
- Daughters, wives and mothers end up being a burden in poorer areas because tradition blocks them from earning money. Killing newborn girls and abusing wives are real in such regions.
- Girls are brought up with a stronger sense of esthetics, fashion and ownership. Societies motivate them differently from boys, limiting their earning power. As a result, as grown-ups they are forced to depend on men for their fake wants. Even though the wants are fake the learned likings go deep enough to trigger depression when unfulfilled.
- Childbirth has become more painful because most get pregnant after the teenage years. Our school system penalizes teen births. In an ideal society the mother will have no special duty to bring up a child. Schooling would be informal and unstructured, leaving people free to birth at an age when tears heal faster. A first pregnancy should be when a she is biologically ready. This medical fact is now clouded by linking pregnancy to lost school years, psychological readiness, and enough earning power to bring up a child.
- The pill, adjusting hormones to block egg production, can have side effects. Having many kids is even more bothersome. Forcing a man to wear a condom is unpleasant for both. Our family systems leave us only bad choices.
- Concealing menstruation is another arbitrary restriction. Regularly inserting and leaving a tampon up the vagina, to soak up

blood, is uncomfortable. Menstrual blood should be cleaned up but need not be hidden entirely.

- Research on disease targets men. Most researchers are men. Female liberationists correctly pointed out the effect of aspirin on heart disease was tested at first only on males. They rightly claimed females are motivated the wrong way by our systems.
- The weaker gender is not fully free to travel or wander and has to rein in wanderlust everywhere. Fear of rape and lack of money leave it less independent. With sex attraction out of the way, a true society will let both genders be the same except in matters related to biology.

The ideal world frees women of money worries, childcare issues, and putting up with partners, while still providing a system to support them when old, ill or handicapped.

14.3 Ugly diseases will spread

Venereal disease would be widespread.

Most STD's (Sexually Transmitted Diseases) are less harmful than is commonly thought. Antibiotics can cure syphilis, gonorrhea, chlamydia and other bacterial STD's. Focused and funded research can produce vaccines to contain, and then eradicate, viral ones. Vaccines for herpes and hepatitis are already in various stages of clinical trials. The most common disease, genital warts, caused by the HPV virus, has a vaccine for women, marketed currently as one for cervical cancer. We still have no vaccine for the flu or cold viruses. But these were expected to be hard; if they were easy, since they are evolutionary old, selection would have found a genetic solution. The common STD's are not evolutionarily old. When HIV first infected humans is debated but the length of time is not even centuries, it is decades. Syphilis cropped up around 500 years ago, and its origins are also controversial.

Our only serious STD, AIDS, spreads more commonly through contact with infected blood, from shared needles or through homosexual acts. The rate of HIV-1 transmission per heterosexual coital act, vaginal sex, is around 0.0082 at peak infectivity.[77] This happens at the onset of the infection cycle, and reduces to around 0.0001 when the disease is latent for a few years.That is a peak of about once every 120 acts, for unprotected sex. But this is for 120 continuous matings with the same woman, depositing a viral load every time. If the mating acts are all with different women, there is next-to-nil chance of passing the infection on, assuming no genital warts or other STDs. Unless venereal diseases and similar complications are present, this disease spreads through normal heterosexual sex mostly from repeated intercourse between the same partners. Mathematically, once a person is infected and mates continuously with the same partner, the probability of passing on the virus in each mating act is not independent. With each act, the chance likely goes up, at least to a threshold point, since some of the viral load from the previous mating act is likely to be hanging around. Sperm survives up to six hours in the acidic vagina, and an average of 3 to 4 days in the fallopian tubes. The virus can be expected to survive for the same time. The net result is the chance of catching the infection on the second mating is substantially higher than in the first, at least for male to female transmission.

In the ideal world diseases like HIV, which are transmitted by repeated sex between the same man and woman, will not catch on. The chance the HIV-positive person has continuous multiple intercourse with any one person drops to almost nil. Conversely the likelihood a person without HIV has continuous multiple intercourse with many infected people also drops to almost nil, since infected people would be an insignificant number at the start. In this situation this virus will not be transmitted via normal copulation. Our current statistics are skewed because partners AIDS-afflicted people have are those probably with another infection.

Unfortunately this does not help with the transitional world. The prevalence of HIV is however not large enough for this to matter. Even in the transitional world, any accidental HIV is not going to spread faster than in the monogamous system. Especially with periodic checkups, absence of other STDs, and only straight penile-vaginal sex. Men who get HIV will have to use condoms. [Need to check whether female condoms work].

14.4 Inbreeding is bad

Free sex causes genetic defects since incest goes unnoticed. Incest causes genetic defects by letting recessive alleles occupy both gene pairs in a chromosome pair.

If the two gene pairs in a paired chromosome differ, the locus is heterozygous, else it is homozygous. Of the two versions, alleles, one may dominate the other. In this case, in heterozygotes the dominant allele is active and the other dormant. The dormant allele, the recessive, could be a defective one. Since it plays no (or only a slight) part in the body's constitution and so does not affect reproductive fitness, natural selection will not act on it. A population could have a large number of such defective alleles. With random mating, the number of heterozygotes stays about constant (see the Hardy-Weinberg equilibrium covered in Appendix A on page 349).

With incestuous mating, the chance of the kids being homozygous with the recessive, defective, allele goes up. It is likely both parents are heterozygous at the locus, and there is then a 25% chance of the kid being genetically defective (homozygous for the recessive). This would be true of almost all such gene locations. There have been instances, such as in Pharaonic Egypt (brother-sister marriages) and the early Jews (first cousin marriages), where incest was practiced with no known problems, but most societies avoid it by custom or law.

"Psychological and social mechanisms for avoiding incest exist in all species of primates . . . For example, males, females, or members of both sexes, leave their natal group upon reaching sexual maturity." Kano, p 2.

It takes more than ten years for a child or sibling to grow to puberty. If free to travel as we please, we would move away from our birthplace by that time. In the ideal world, shuffling, caused by people moving, will make incest vanish. Mating free with diverse partners, relocating constantly from wanderlust, one would rarely have sex with blood relatives. Few would even come across these as they move.

One could argue boys develop a sex drive before puberty. Incestuous sex leading to kids is the negative, not the mating per se. This can happen only after the puberty stage. And most kids would start to move around by the time they are past the toddler phase, leading to about no pre-puberty incestuous sex as well. Looked at from Kano's point of view, in the ideal world of the human primate, members of both sexes will wander away from their birth group well before reaching sexual maturity.

14.5 We evolved to be monogamous

Wrangham and others in argue cooking, and females trying to protect cooked food from other males, led to a female bonding with a male to stop thieves.[78] Others have argued monogamy arose for either raising children, by women looking for protection, or from mate guarding by men. Klein, for example, believes the reduced sexual dimorphism, difference in size between male and female, in H. ergaster, means it was moving towards a monogamous system.

When any evolutionist says humans evolved monogamy or pair bonding, what they mean is one of our ancestor species evolved a set of traits which, in the EEA, led to the formation of pair bonds. Natural selection selects for behavior, not genes. It would have selected for the pair-bonding behavior, and indirectly the set of genes which promoted it, by coding for subtraits which within the savannah milieu of the bipedal, large-brained homo genus, would have led to the phenotype of pair bonding. There is no single gene coding for monogamy. What we can see are the subtraits or the proximate behavior.

The actual behaviors, the proximate behaviors, natural selection did select for are male jealousy, female sex preferences and nepotism. The first, jealousy, is tied to the mate guarding hypothesis. The second to the men-as-body-guards theory. And the third to the monogamy-for-raising children theory.

The EP modules we developed would code for these proximate traits. As we saw in some detail, these modules get triggered on specific input. Jealousy, preferences and kin selection are all adaptations which automatically get deactivated in an ideal world where situations which lead to jealousy are absent, the sex preferences become irrelevant, and kin cannot be recognized, that way blocking kin selection.

All objections starting with "We evolved to be . . . " are answered this same way. We did not evolve any EP modules which act independent of the social environment. The objection is often founded on the popular, imprecise, notion that natural selection selects preferred genes.

14.6 What we have now is enough

The West could convince the world to accept its tenets: technology, capitalist competition and fixing unhappiness with medication. This would lead to a world with war a word of the past, hunger just a memory, more open on sex, most living an improved physical quality of life longer.

At a practical, personal level growing GDP does not make us much happier because stress from having to work when bored rises with it. We wake up hoping for a day better than yesterday, the wish to retire driving the will to work. Unable to use logic as a guide everyone breaks down at least once from the pressure to cope.

The response has been to fix shattered minds with therapy and drugs. Paxil and Prozac, Zantac and Zoloft, leave us far from happy. They treat symptoms, have lingering after-effects and ignore the root cause. Repairing chemical makeup is no lasting fix to stress and damage caused by continual social, family, and economic pressure. The other option, to distract us with a taught, learned liking for various kinds of fun cannot be sustained. After a time such fun gets stale making people bored with it.

In the shifting kaleidoscope of our systems, capitalism is another new meaningless pattern. It makes us compete to produce more and invents distractions to keep us busy against our nature. Studying or working in a continuous 8 hour shift is not something our brains are designed for, since the EEA had no such system. Competition and forced work make us restless and unhappy, however well-disguised or efficiently structured they are. Against every company which succeeds, we need to balance the many which competed against it and failed, leading to labor wasted by its employees. Improving our lives through technological progress, with no competition, is ideal.

In general, our systems have drawn on consciously suppressing the output of the brain's innate negativity mechanisms. Jealousy is handled not by cutting off the input, that is by creating conditions which do not trigger it, but by teaching people it is wrong to be jealous. To ensure people continue to follow that teaching, rules are created. To make sure rules are followed, punishment systems get implemented, with enforcers and overseers of enforcers. To make sure the overseers do not fail, a circular system, where the masses elect the overseers is put into place. This creates a society in unstable equilibrium, lurching from one state to another as times and circumstances change. Deactivating the negativity systems by ensuring they receive no input creates a stable equilibrium state, since happy individuals will likely share and work well with others as well.

14.6.1 Our family systems

The family way is another strongly defended faith, by the religious and non-religious alike. The alternatives seem risky, and this drives people to justify the system, and believe in the justification. Evolutionary psychology goes against the trend, seeing the system for what it is.

Hamilton's inclusive fitness predicts psychological mechanisms will arise which push people toward helping close genetic relatives more than distant blood relatives, and distant relatives more than non-genetic relatives. This rule has been used to explain how a number of traits arose. Menopause, for example, is thought to have evolved to free grandmothers to take care of grandchildren. This assumes only humans have it; something still not clear, since gorillas in captivity show menopause.

Hamilton's rule predicts many things about kinship:

1. Kin terminology, centered around a person, will be universal. Cultures will have words for my brother, my sister, my father, my first cousin, and so on.
2. Kinship systems and terminology will distinguish along the lines of gender and generations. Brother, sister, and cousins are the same generation. Father, mother, aunts, uncles of the previous one. Son, daughter, niece of the next one.
3. Kin relations and closeness will be linked with genetic overlap.
4. Degree of solidarity between kin will depend on genetic overlap.
5. Elders of a family will pressure the younger to cooperate toward non descendant kin more than they naturally feel. This is similar to the parent-offspring conflict.
6. Everyone is aware of their real relatives, across cultures.
7. Words which indicate genetic kinship, such as buddy brother

and soul sister, will be used to influence strangers.

Those seem more like descriptions of how things are, rather than things which need to be experimentally verified. I will address this and other criticisms at the end. There are some less intuitive predictions. We are expected to help the younger more than the old, since they have more reproductive potential. However, in the age range before puberty, we should be inclined to help the older more, since they need less time, and are hence exposed to fewer risks, before reaching reproductive potential. This last prediction is wrong, since surveys have reiterated the obvious: we help infants and toddlers more than we do older children. Mechanisms beyond kinship selection have to be invoked to explain the discrepancy.

Also, women exhibit closer kin ties than men across most cultures. They recall kin better, and mention family roles more frequently when asked "who are you". The explanations for this are again tentative.

Which brings us to a central human tradition, extended family ties retained after kids grow up. Such groupings are rare in the animal world, with roughly 3% among mammals. Stephen Emlen defines families as cases where offspring continue to interact regularly, into adulthood, with their parents. I will call this the extended family to be clear. This is different from the nuclear family related to bringing up offspring, which evolution theory explains is the basic parental care module evolved to protect the 50% genes invested in children. Per Emlen, extended families form when (1) more offspring are produced than there are mating chances, (2) offspring must wait to build up resources to join the mating competition, and (3) when the benefits of staying at home are large. David and Daly have suggested the relatively early menopause of women may have influenced the evolution of this setup, since post menopausal women would wish their offspring to be with them. One of the predictions of the theory is that altruistic help with rearing the young will be more prevalent among such families than among comparable groups lacking kin relatives.

The EP take on our family systems is grim. Buss's *The Evolution of Desire* has two chapters on staying together and sexual conflict. Emotional manipulation, deception, clashes over money, sexuality as a tactic to manipulate, psychological abuse including condescension to block perceived alternatives, are all adaptive behavior, subconsciously designed toward an aim. They are not learned, and are consistent across cultures. This squares with most people's personal experience; the statistics there prove it. The only reason those chapters are not taken as repudiating the family system is because he presents no alternative, that being outside the scope of EP. The trouble is not the hardwiring; it is a family system forcing two people together to raise a third and maybe a fourth, that way triggering all the negative adaptations. Most people live in an unstable equilibrium with the various subconscious modules pulling and pushing various ways. Objectively EP says our family systems will have conflict, stress, and commitment to balance the stress, however much counseling, therapy and guidance we get.

On the sex front, research shows a man's urge for his partner diminishes steadily over the years. As wives age, husbands are less interested in them sexually, and are less happy with sex.[79] The midlife crisis is often the wife getting to be middle aged. A man devotes less time to guarding an older wife from other suitors, because she becomes less desirable to him.[80] Per EP this suite of behaviors is not learned and cannot be unlearned; as women age, their reproductive potential diminishes, and men are hardwired to feel less attracted to them. Fading looks is one immediate reason.

The other is variety. In most mammals including humans, males feel aroused more with new females. This is known as the Coolidge effect.[81] The waning of lust for the same partner immediately after mating is considered an adaptation, that is it is subconscious. As Kinsey noted: "There seems to be no question but that the human male would be promiscuous in his choice of sexual partners throughout the whole of his life if there were no social restrictions . . . " Our family systems are not men-friendly. Nor are they women-friendly. Marital conflict, seen as inevitable by EP, harms them as well.

14.7 No change is comfortable

A few refuse to think of an ideal world, being conditioned by the one they live in. It is hard to analyze main tenets of our systems since those shape our thinking. The impulse to question the beliefs that underpin our current daily goals, feelings, emotions and ambitions is difficult to sustain. Given a choice between this belief and leaving things alone, some get busy proving their background differs enough in class and personality, to be satisfied with the status quo. Many others try to pick holes in the alternate vision, specifically in which way the transitional world described later would go. The book aims to comprehensively cover what the second group objects to by presenting an alternate in detail.

14.8 Evolution theory says there is no ideal world

Evolution is a random process, and its products are largely fated to live in the worlds they find themselves in.

14.8.1 Evolution's faith

Many atheist scientists build a vision of life and its meaning on top of the facts of evolution. Dawkins, in *The Blind Watchmaker*, trumpets his atheism on the cover page. Gould, who debated Dawkins vigorously, emphasizes he is an atheist. Marvin Minsky, in his *Society of the Mind* says everything is from blind chance. These translate the randomness of random mutation to its English meaning, 'aimless, haphazard' mutation. Random, in common English, denotes something unplanned, chaotic, the opposite of structured design.

As practical evidence of this aimlessness, the faith of evolution points out our anatomy is inefficient, the knee joint weak, the appendix unnecessary and causes painful appendicitis, the adrenal gland is in the kidney when it should be in the brain, and myriad other details are nonoptimal. Redundancy in the DNA and the brain is also believed to be inefficient. Given the billions of years nature has taken, we definitely would have done better. While it is true the knee caps we design today do not flex as well or last as long, given a billion years, we can design better stuff than what we are born with. That we already understand so much shows how easy it is to design life. That nature took so long means it has been acting on a haphazard source of change. Retroviruses in the DNA also mean we were produced by blind chance. They are from chance infections of viruses. The mitochondria, an almost self-contained body within most living cells, is from a proto-bacterial infection a few billion years ago. A design depending on infections is not a planned one. The ear is another example of the roundabout caused by evolution. The human ear converts airborne sound vibrations to those in a fluid, inside the cochlea, and then detects them. This is because the hearing system first developed in animals living in water, where the cochlea was sufficient. The air to fluid conversion, via the ear drum and the three small bones, developed later on top of the original mechanism.[82] Not efficient design. Why not just make what you want directly, and make it perfect biologically?

Dawkins argues those who believe in a creator need to explain how the creator was designed.[83] Otherwise, as per him, a faith in a creator just postpones the problem of design. Specifically he refers to life emerging as a natural process which should not be associated with a creator intervening.

Astronomy and physics support the aimless origin theory. The moon, essential to life on earth, was formed by an asteroid colliding by chance with earth. Physics laws have chance in them at the quantum level. And the universe has no meaning since it is bound to expand and end in almost nothing in the far future.

As faiths go, the creator-less, random chance one is as strongly defended as the others. Mostly by comparing it to creation with a God who has interfered in the world at various points. The faith explicitly states there is nothing inevitable about humans appearing on the scene. Many other outcomes were possible. Its believers concede no alternate explanation. They believe their faith follows directly from the facts of evolution.

I will first show this is not so. There are other faiths which can fit the same facts, at the about the same level of rationality and common sense mixed. Being faiths, none of them can be proved or disproved. I will not draw on any of these for sustaining my vision; one alternate is presented here just to show the faith of evolution cannot be used to object to an ideal world. The facts of evolution cannot automatically lead us to conclude that 1. Our origins are unplanned, and 2. Hence we are suited only to the society we find ourselves in. Many evolutionists think so because the alternate they focus on is the story from Genesis. Few have the will or the time to exhaustively eliminate other possible faiths.

14.8.2 Fitting another faith to the facts

A creator created us starting with the big bang, the initial state of the Universe as per today's physics. The world was created with a set of initial conditions, following a set of rules, the rules of physics. Those rules are probabilistic at the quantum level, but not at the macro level. The processes associated with life are not expected to be quantum, organic molecules being big, the biggest known. Given the initial state of the Universe, and the deterministic macro laws of physics, it was inevitable humans would be created on Earth. The equations which would prove this are too complicated to write, but fundamentally, since the Universe follows the rules of physics everywhere and at all times, and since those rules are deterministic at the level that controls life forms (DNA, cells, cytoplasm and so on), it is deterministically guaranteed humans would come on the scene. There is nothing inevitable about humans springing up in the model evolutionary theory uses. There is something evitable about humans originating in the model molecular physics uses. The laws of physics allow no alternate paths at the level of genes and cells.

The facts of science, including evolution theory, are solid. Random mutation is random in the sense the outcome of a coin toss is random. At the granularity of molecular physics, it is deterministic, but since molecular physics analysis is hard to apply beyond simple systems, biologists take a higher-level approach at the level of cell chemistry, and view mutations as random. They are not aimless or haphazard from the viewpoint of a creator who understands physics. Or from the viewpoint of those who use molecular physics as the analysis tool.

The various problems with our anatomy are overridden by giving us intelligence to figure out the problems and fix them. Created we are with brains to understand DNA, organs, and to make tools to take out a defective appendix. Self-repairing mechanisms able to fix flaws once noticed. Every flaw an evolutionist points out can be countered the same way: we have been created with the brains to understand the flaw and fix it. Flaws not noticed, of course, cannot be debated. That leaves only those known but not fixable. As we will see in Chapter 15 on page 293, there are no such. To be defined as a flaw, we should have a superior version in mind. A version that can be planned and made.

As to whether the design is optimal, the restrictions are out of the range of what we know. The creator did not just create. It also created in a way we would be able to understand the rules of the material world. This involves examples which allow us to deduce those rules. A fully formed, fully perfect being created spontaneously in a world, which then starts changing following the rules of physics, would have a harder time figuring out those rules. The design hence had to create intelligence, and make sure the created intelligence had the material to learn the rules of physics and biology reasonably fast, both to improve its quality of life, to reproduce and colonize the whole world, and to ensure access to resources as its population multiplied.

I will show in a later chapter free will blocks us from knowing everything about our own brains in the sense of predicting exactly how it will respond to an arbitrary set of inputs. We do not have the power to design an intelligence the same as ours, though we can reproduce, clone, or chemically synthesize another intelligent being. Design here implies understanding exactly how the designed product works. The presence of free will means we cannot understand our exact workings. How this fits with science will be covered extensively in Chapter ?? on page ??. How this fits with the alternate faith is clear. Arguments about how inefficient our creation mechanism is, are dead-ends because that design is outside our power and hence its trade-offs will remain unknown. Arguments about how inefficient existing biology is, are also dead-ends because a part of that biology, intelligence, can override the other perceived flaws, making them immaterial.

What about the Dawkins objection? Who created the creator? I will later argue, assuming we have free will, this question cannot be answered. It is beyond the limits of our powers. Dawkin's faith of atheism is no answer. It leaves the time t=0 problem. While physics explains the laws of the world starting from the big bang, how the Universe came into being at the point of the big bang cannot be answered. Even if physics manages an answer such as branes colliding causing the bang, that leaves the problem of where the branes come from. The solution just pushes back the point at which we can assume time started, the t=0 point. Every solution will have its own t=0 point. The force that started the clock ticking can be called the creator. It did start the ball rolling with a set of initial conditions and rules which would have led to us over a few billion years. The other explanation, that the Universe came into existence at t=0 in a single quantum leap, explains nothing, since it resorts to a highly improbable event. So improbable it could be seen as mathematically describing creation.

The laws of physics hold at all times. But time has a beginning. There the power to explain ends. Atheism does not solve the problem. Neither does any theist faith. But this does not mean theism is wrong. One cannot reject a faith because it cannot answer an unanswerable question. The Universe came into being with a set of conditions and rules so orderly it seems as if there is a creator. Nothing in Dawkin's well-written 450 page book disproves this.

The difference from the evolutionist faith is the level at which origins are analyzed. It is imprecise to ask whether any scientific theory is correct. The complete question is how accurate the theory is and how precise its results are, for a particular problem. Newtonian theory of planetary motion is correct if we do not need to be precise enough to be influenced by rules of relativity. If we need to be more precise, then Newtonian theory is not correct; the general theory of relativity has to be employed. So why not always use relativity theory? Because it calculates complexly, and we cannot often solve its equations. A higher level, less precise theory, Newtonian mechanics, gives a rough approximation where the more detailed theory might provide none. In our case the more detailed theory is the deterministic model based directly on the laws of physics. The less precise and more practical theory is the chance-driven model of evolution.

For thinking in terms of a faith, it does not matter how complex problem solving is in the more detailed theory, since the idea is not to use the theory practically. Just showing the detailed theory is correct is enough to support the argument. Science agrees with the determinism of our theory, since it relies just on physics laws being deterministic at the non-quantum level, and organic processes being non quantum. Science cannot use this approach, since the detailed theory is too complex to analyze anything with. Levels of explanation a faith and a science can use are different. The facts of evolution can lead to this alternate faith if the level of explanation is changed, something those who swear by the faith of evolution miss. Evolution theory is the superficial model explaining our origins. Physics provides the deep model. In the deep model, our origins are deterministic, if we assume animal brains show no random quantum behavior.

As stated before, evolution theory simplifies the nonessential to get tractable models. The associated faith overlooks that part of evolution theory simplifying a deterministic process into a chance-driven model. A deterministic model is seemingly too complex to be scientifically valuable, but at the abstract level at which faiths operate it is the one that matters.

14.8.3 Applying to the ideal world

The alternative faith has appeal in that it accepts science fully, but leaves aimlessness out. I will, however, assume an agnostic view to build the concept of an ideal world. Mainly to avoid getting tangled in the non-scientific, never-ending, debate that would accompany any idea science alone cannot prove or disprove. However it does mean I will not address objections to idealism rising from the faith of evolution, as the alternative undermines the evolutionist faith's claim to being the only conclusion possible and hence the only scientific one. The only evolutionary objections looked at would be those flowing directly from science, including those from the theory of genetic mutation, drift and natural selection in various forms.

The laws of evolution are descriptive, not prescriptive. They are the laws of a model which describe how we came to be. Evolution is a theory of origins. The model states mutation and selection operated in the past to fashion the species we see today. The laws are statistical and can be changed from within. Nothing in the theory states genes have to change from one generation to the next, randomly or otherwise. Cloning stops mutation and selection. The laws do not limit humans the same way the laws of physics do. For humans continued gene change is less a guiding force since we can reverse it. Humanity can be free of evolution because technology can block or undo it. This has already happened to a good extent. We have the means to understand DNA and roll back changes with molecular engineering; a crucial, qualitative difference which sets us apart from animals. The chances of cloning errors is smaller than the probabilities of random mutation, and can be made to almost vanish over time with better technology. Deterministic evolution, which produced us, ends with us. Evolutionary behavior applicable to animals does not dominate us because our intelligence is qualitatively different in that it is able to end gene mutation.

Evolution describes changes at the level of replicating genes across generations within organisms. The level of detail at which it works is often not enough for our purpose. Most of the theory deals with ways in which specific genetically determined behavior or anatomy arose by some members of a species reproducing more than others. I will cover some variations put forward to explain behavior which could block an ideal world. Natural selection, in various forms, is often used to explain how genetic traits came to exist. Selection cannot be used to prove a trait is genetic. It can be used only to explain the origin of a trait once it has been established to have a genetic part.

When evolutionists say a behavior is naturally selected for, the popular press often translates this to mean the behavior is hardwired. While this is correct, it is not complete. What an evolutionary scientist would mean is, that particular behavior was selected for in the environment in which it arose. In other words, the hardwiring is for a set of traits which would lead to the behavior in the social milieu of its birth. Whether the same set of traits would lead to the same behavior in a different environment is something evolution does not answer. It is a point crucial to us. Humans have not genetically changed much in the last 50,000 years. Hence when evolutionists say a particular behavior, say aggression, is hardwired, they mean those with a set of traits which combined would have led to an aggressive temperament in the African savanna environment of our ancestors more than 50,000 years ago, ended up reproducing more than others. This legacy has left us with a set of genes which leads to a set of traits, which, in the primitive savanna hunter gatherer world, would have disposed us to be aggressive. At issue is whether the same set of genes, and the traits they lead to, would cause us to be aggressive in other environments as well. What we know of our ancestral environment provides no clear answers.

15 What is in our power

Science and religion have continually fought over our ability to recreate nature. Religion attributed phenomena unreproduced, even if only on a smaller scale, to gods. As these became rare, atheism gained ground asserting there was no creator.

What is the state of our effort to control and reproduce our natural environment? What of the future? This chapter and the next switch gears to use math and physics for the answers.* The switch from social analysis to math is needed since our power and limit are best modeled by computation theory. The present state of technology is irrelevant, it being limited by physics alone.

15.1 What we can build

Here, rather than analyze each tool, device and mechanism used to harness the environment, we will explore the only automated model around. The robot, based on electronic or mechanical principles.

15.1.1 Math model of a robot

To understand how a robot computes it has to be decoupled from technology used. Computing needs to be understood isolated from electronic or mechanical devices which implement it. Let us start to build our model focusing on a calculator.

15.1.1.1 Calculator operations*

Calculators do arithmetic. They add, subtract, divide, multiply and repeatedly multiply. Most calculators do even more with numbers providing functions like factorial and logarithm. To manage the complexity the many operations to be supported need to be reduced to a few primitives.

Repeated multiplication builds on multiplication. To multiply is to repeatedly add. Division is inverse multiplication and subtracting is adding inverted. Other esoteric functions are inverses of basic ones. Logarithm, for example, inverts repeated multiplication, already reduced to adding. We end with addition as the building block for other operations.

* Sections marked with a * use math.

How to add, say 2 plus 3? It is the number counting 2 numbers beyond 3. Similarly 14 plus 23 is the number 14 beyond 23. Addition reduces to counting.

Counting is truly fundamental. It starts from 0 and goes up. Concepts of 'less than' and 'greater than' are also related to counting. A number which comes before another in the counting scheme is less than the second number. A number coming after is greater. To check if a number x is less than a different number y, count from 0 and see which of x or y comes first. The first is the smaller number, the other the larger.

This scheme assumes we are able to check if numbers are same while counting with a mechanism to see if they equal each other.

15.1.1.2 Fundamental operations*

How to count and to test if numbers are equal? Both depend on how they are written. There are many possible ways but the dominant one is the ten-based, Arabic numeral system.

In this system counting goes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, . . . Numbers are written as a decimal digit string. Two hundred and thirteen, for example, has decimal digits 2, 1 and 3 in that order. Only one set of counting rules is required for this system. The number which comes after $x_1 x_2 \ldots x_n$ in the counting scheme is constructed by these rules:

1. Define NextDigit(0) to be 1, NextDigit(1) to be 2, and so on, with NextDigit(9) being 0.
2. If $x_1 x_2 \ldots x_n$ are all 9, rewrite as 1 0 0 0 . . . [n times] and stop.
3. Otherwise generate $x_1 x_2 \ldots$ NextDigit(x_n). After this, if NextDigit(x_n) is 0 ripple the NextDigit() leftward. The operation stops on a NextDigit() which is nonzero.

The counting operation will be shown with the 'up' symbol |. For example, |239 = 240. Similarly ||19 = |20 = 21. How | gets implemented depends on the writing system chosen. The result of the | operation (counting) is independent of the digit system used.

We can now write main arithmetic functions with the following added rules:

4. (x) can be rewritten x
5. $x - y$ can be rewritten 0 if x matches y
6. $x - y$ can be rewritten $|(x - |y)$ for all other cases

7. $x + 0$ can be rewritten x
8. $x + y$ can be rewritten $|(x + (y - 1))$
9. $x \times 0$ can be rewritten 0
10. $x \times y$ can be rewritten $(x \times (y - 1)) + x$
11. x^0 can be rewritten 1
12. x^y can be rewritten $x^{(y-1)} \times x$

As an example, using => for rewrites, for $1 + 2$, we have the rewrite sequence below:

	$1 + 2$	
=>	$\|(1 + (2 - 1))$	by rule 8
=>	$\|(1 + \|(2 - \|1))$	by rule 6
=>	$\|(1 + \|(2 - 2))$	by rule 1
=>	$\|(1 + \|(0))$	by rule 5
=>	$\|(1 + \|0)$	by rule 4
=>	$\|(1 + 1)$	by rule 1
=>	$\|\|(1 + (1 - 1))$	by rule 8
=>	$\|\|(1 + (0))$	by rule 5
=>	$\|\|(1 + 0)$	by rule 4
=>	$\|\|(1)$	by rule 7
=>	$\|\|1$	by rule 4
=>	$\|2$	by rule 1
=>	3	by rule 1

We have reduced computation to rewrites applied on top of the | operator, and a check if digits are similar. The | operator defined by rules 1 through 3 needs a rewrite on digits and a check against digits 0 through 9.

Division cannot be reduced this way. It can be carried out using 'less than' and 'greater than' relations developed earlier.

13. $x \div y$: Count up n starting from 0. At each step check if $(n + 1) \times y$ greater than x . If so stop with n.

15.1.1.3 System requirement*

From the above description the calculator needs:

1. A symbol alphabet with digits 0 through 9, and operators +, −, ×, ÷ and repeated multiplication.
2. The ability to read these digits from some input medium.
3. The ability to rewrite the input symbol string.
4. The ability to restart calculation with the new string.

We will call the input medium an input tape. Our model now needs an input tape and working tapes, with cells which contain symbols. The system needs to scan tapes and read and write cells. The scan can be done several ways but the simplest is a cell-by-cell right-to-left one. Because the Arabic number system calculates right to left. We could assume each tape has a separate read head and a separate write head.

Next is the design of the logic to control tapes. The control logic needs to act on what it reads from the input one. It could act on entire tape content or just content of the cell the read head is on. To choose between the two we need to look at tape size in more detail.

15.1.1.4 The system tape*

A specific value, say 40000, for the number of tape cells is problematic. This would limit the largest number one could calculate with. The largest number we can calculate with is unlimited. Below infinity since we cannot count up to it. The number is finite but not fixed, so our tape needs to be unbounded to account for this.

Does this rhyme with the final goal of modeling how a robot computes? We could assume a robot's input is just the real world. Is that world unbounded?

This is often answered wrong. According to physics the universe is infinite but the part which affects us can be considered finite. This point is contentious, so we will look at both possibilities.

If the world that theoretically affects us has no bounds then a limitless tape approximates it. If the world that affects us is finite, it still is endless. The 'observable' universe is made finite by the light-speed velocity limit. Since the universe started almost 14,000 million years ago, forces from beyond 14,000 million light-years have not reached and cannot interact with us. A light-year is the distance light travels in a year. Since it measures distance, the observable universe is 14,000 million light-years in radius.

That is finite. But this number gets larger with time. As time passes the radius grows as forces from farther off in the universe reach us. As per today's physics the shortest time slice we can measure is the Planck time. A tiny fraction of a second. The shortest distance measurable is the Planck distance. Again a tiny fraction of a millimeter. Considered a discrete system the observable universe expands in radius by a Planck length in Planck time. The units are defined this way. This is why the analogy to an unbounded tape is almost exact. It is impossible to reach the end of the tape because it stretches by a cell every time slice and the head moves at most a cell in that time.†

15.1.1.5 The system-control logic*

An unbounded model rules out a control logic which acts on the whole tape content. The logic will have to look at unending stuff before it does anything. It might spend all its time just on this. The possibility left is one that sees only the cell under the read head.

But the control needs to remember past history of the tape. If not the complete past at least a summary, called a state. The system moves from state to state as it computes and the history changes.

The system starts off in an initial state with some input on the input tape and the read head on the rightmost cell. At each time step the system reads the current cell and from its value and the current state decides, acts and moves to the next state.

Note this transition is based on matching cell content to a symbol set. The check here is simple. The calculator we developed needed just a direct symbol match check. Similarly the act consists of moving the head left, right, or keeping still, and writing to the input or working tape or both. Again this is all the calculator needed.

The control logic is a set of states linked with transitions triggered by input symbols. Each link also has an action for the head and for writing. The control logic is fixed in advance and is finite and bounded.

15.1.1.6 Calculator implementation*

In computer science the basic model used is a TM (Turing Machine). A TM computes using a read/write head which moves left or right and marks a cell on an endless tape. A control store puts into effect the logic which drives the head, as mentioned above. The control store consists of state and transition, drawn as an FSM (Fi-

† The universe constantly expands and spreads and thins matter out. However this changes little—it replaces matter by vacuum. Vacuum is nonempty having energy which affects other things. Something called the Casimir effect is such an interaction. Changing matter to vacuum changes tape cell content but does not remove tape sections.

nite State Machine), with state shown by node, and action and transition by labels on arrows. See figure 15.1 on the facing page for an example store pictured as an FSM. The machine operates with input 19 as traced in figure 15.2 on page 300.

This FSM implements rules 1, 2 and 3. I have avoided the control store (state machine) for a full calculator—these machines are long and tedious for even basic operations. Books on computer science theory cover this part in detail. For our purpose all software-controlled entities can be thought of as a TM, streamlined and optimized. A robot also is just a TM with a complex control store.

15.1.2 Predictability of our robot

How such a robot reacts is known in advance. The program sequence and input fully decide how it behaves. This analysis would be complex but there is no fundamental restriction here. Our robot behaves predictably.

Predictable behavior, in a way, leaves the robot too machinelike. Can one be created which has built-in unpredictability? Robots can be controlled with probabilistic programming or their behavior can be tied to some person's action. We will discuss both.

Probability mathematically models chance or likelihood. If a normal coin is tossed the odds it would turn up head is 50%. The probability of head is then 50% and of tail 50%. The possibilities are two and the probabilities for the two add up to 100%. Probability of an event in any model should be between 0% and 100%. An impossibility is 0% probable and a dead certainty 100%.

15.1.2.1 Randomness

In common usage random means aimless and haphazard. The one in 'random mutation' of evolutionary theory is associated with this sense of the word in popular science literature. It is this meaning which allows evolutionists to claim the world is minus a creator.

In science 'random' refers to probabilistic events. These arise from the difficulty in calculating deterministically. A coin toss outcome, for example, is fully known from the laws of physics. It is normally considered otherwise because a deterministic analysis is too difficult. Randomness of random mutation belongs to this class. When evolutionists publish in science journals they use the word to mean probabilistic behavior used to approximate deter-

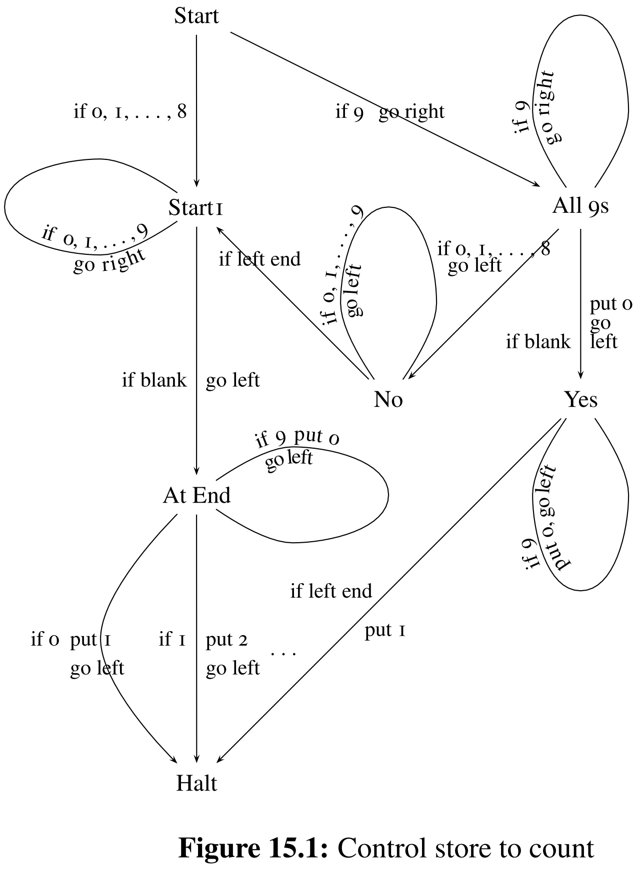


Figure 15.1: Control store to count

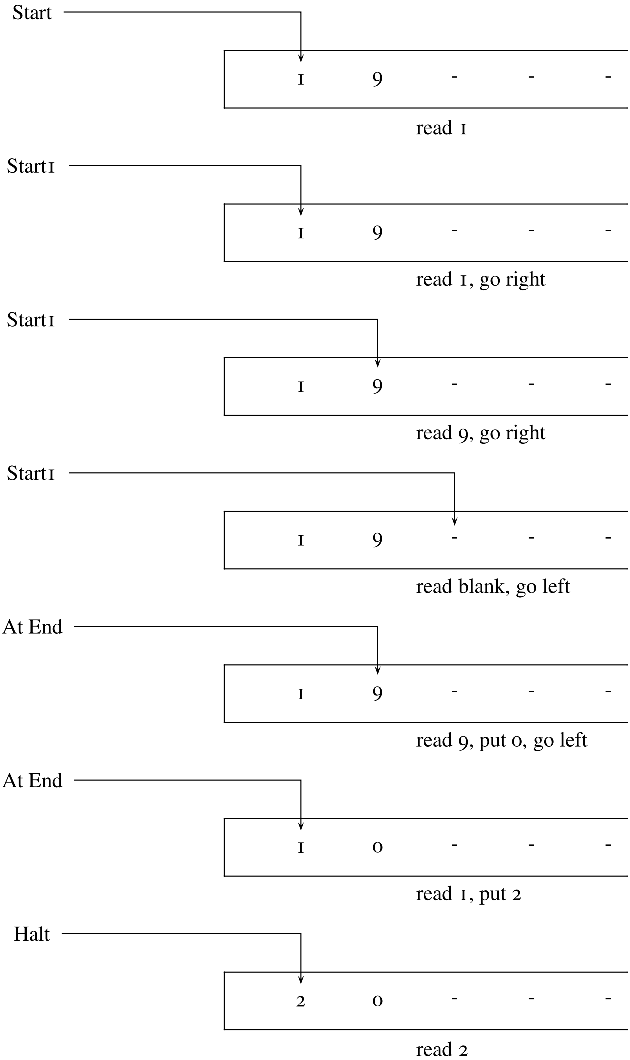


Figure 15.2: Step sequence for input 19

minism. They then copy that word as is to their populist articles. In which context it stands for aimless. Subtly implying science has established gene change over time is aimless and haphazard.

Quantum probabilities are true ones in that they do not approximate determinism but are intrinsic to the modeled object.

Computation theory uses the same term to refer to probabilistic entities, as in science, and to uncomputable stuff. There are numbers whose digits are uncomputable. Such numbers are sometimes called true random.

True randomness cannot be simulated. It can be approximated closely using uniformly distributed probability for outcomes of an event. That is, by assuming all are equiprobable. So to simulate a random event with 10 outcomes each is given a 10% chance.

15.1.2.2 Probabilistic analysis

Note probability is an incompletely defined concept. An example probability of 23% for an outcome does not imply it would be seen 23 times in 100 tries. The chance of that is small. What it says is the outcome would appear close to 23 times in 100 tries. Where 'close to' is left open. It can be described as bound on likelihood but this definition is circular since likelihood is again explained probabilistically.

Probability is therefore meaningful only if systems designed with it work. Probabilistic analysis has been used by economics, sociology, psychology and other fields to be mathematically respectable. Mathematics is abstract. To apply it one needs to start with assumptions specific to the domain. In exact sciences these are validated by correctly predicting a result which any other model fails to explain. In trial and error domains getting things to work validates assumptions.

15.1.2.3 Robotic predictability

Probabilistic programming would tie the robot's response to a source of intrinsic probability. Standard sources, say a coin toss, are not truly chance driven since their probabilistic appearance approximates determinism governed by the macro laws of physics. Probabilities associated with quantum entities are, however, intrinsic. A probabilistic robot can be built by tying its programming to the behavior of such an entity. For an actual robot one could have it measure the entity and act accordingly. The measurement result being inherently indeterminate the behavior of the machine would also be so.

Probabilistic behavior is not unpredictable in the ordinary sense. Most would classify it predictable, just less certain.

The second way is to get the automaton to faithfully follow actions of a person. Assuming what a human does cannot be anticipated, we have a robot with indeterminate behavior. However this is dependent unpredictability. If it turns out the person is predictable then the robot is as well.

True unpredictability needs true randomness. It is unclear whether this exists outside human actions. If it does then it can be exploited to build a robot intrinsically unpredictable. As a working premise I will assume such randomness does exist and we can build systems whose behavior is partly unknown.

15.1.3 A look at our future potential

To project our potential into the future we will track what a science-fiction author once imagined. He foresaw a future with humanoid, telepathic, self-repairing, self-reproducing robots capable of assembling new robots. Capable of creating an assembly line to create new automatons. Of modifying that assembly line. Of controlling human minds. Only for good though. With good defined by their initial programming they were bound by. We will build our projection, step by step, to see how much of this future is attainable.

Self-reproducing humanoids can be built. These just need to know how an assembly line created them. They can be programmed to recreate the setup elsewhere. They can even be programmed to search for raw material, build the right tool, and build the assembly line which would make more robots. Self-repairing machines are possible as well.

Robots could be built able to create more powerful ones. Assembly lines to build new robots can be seeded to build the first elementary one, which would modify the line using tools to build more sophisticated offspring.

15.2 What we can understand: languages

Humans use and understand language. It is easier to study how we understand language than how we use it. Understanding language implies the content is already present; the main question is how we parse the input, spoken, in sign form, or written. Using language is more complex. Apart from the grammar rules, one needs to look at how we decide what to say.

Understanding the word relationships in a sentence is called parsing. This is the first step in understanding any language. The second step is deriving meaning from the word content, the parse structure of the sentence, and global knowledge of the world around us. The second step is again complex and how we do it largely unknown. Hence we will focus here on the first step, parsing sentences. How we do it is still unknown, but there is a solid theory on what kind of parsing rules we use, and what kind of languages require what power in the rules. Noam Chomsky, a linguist, introduced the Chomsky hierarchy of grammar rules to explain this. The idea has been developed further more in computer science, with its math base, than in linguistics. I will the the computation theory view to analyze the expressive power of various grammars and the languages they stand for. The languages do not represent any real human ones, since those are all equally complex. But they could possibly represent those used by other animals, as we will see below.

We start with some special words. A string is a sequence of characters from an alphabet. If we take the Latin alphabet, then “abc” is a string, and so is “def af”. To keep things simple, we will use only lower-case letters in our strings, with no punctuation or digits. Each English word is then a string. If we include punctuation and digits in our alphabet, then each English sentence is a string. An entire book is also a big string.

Languages, human and otherwise, are defined by the strings one can write in them. Not all possible strings that can be constructed from the alphabet are valid in practical languages. English has a finite number of words, and strings which are not words are invalid in the language, except in special cases, say as examples. The set of valid words is the vocabulary, and it is typically defined by a dictionary. For human languages, often by multiple, sometimes conflicting, ones. Similarly not all word combinations are valid in sentences, and so even if each individual word string is valid, a sentence may be invalid. What combination of words make up a sentence is defined by the language grammar. Beyond sentences there are no formal rules on what constitutes correct English. However, practically, sentences need to have continuity in meaning. A random jumble of sentences is correct English formally, but wrong English informally.

For analyzing languages, computation theory, borrowing from linguists (particularly Noam Chomsky), uses a different definition for grammar. Grammar is defined to be the syntax—the rules specifying the correct strings of the language at the word level. Vocabulary is defined the same way as in common speech. It is the set of all words of the language, and hence the set of all words generated by the rules of the grammar.

As an example, consider the grammar with the rules, S->S a, S->b. This notation is the Chomsky Normal Form. The valid words in the language represented by this grammar are a, ba, bba, bbba,. . . . Let us note the rules as 1 and 2. Then to derive the string "bba" we proceed this way: S -> S a (rule 1) -> S S a (rule 1 for the first S) -> S b a (rule 2) -> b b a (rule 2)

S is the start symbol, and the rules are called the rules of production. Each rule has a symbol on the left of an arrow, and the sequence that symbol can expand to on the right. We use small letters to indicate characters of the alphabet (in this case 'a' and 'b') and big letters to show symbols.

15.2.1 Regular expressions

A regular expression is a grammar with a limited set of rules. The rules are all of the form (ignoring something called the null string):

where *x* and *y* stand for any character from the alphabet. Thus, strings like "a", "ab", "aaa . . . " and "abaabaabaaba . . . " can be generated by the rules. The last, for example, would have the set of rules S1->S2 | S2 S2 S2->S3 a S3->S4 b S4->a

Another way to represent the above set of strings is as (aba)* where * stands for "occurring zero or more times. Thus (ab)* | (cd)* stands for the set of strings ab, abab, ababab, . . . , cd, cdcd, cdcd. . . . Plus one other string, the empty string, I will avoid mentioning.

Clearly humans have the ability to understand such patterns. In some cases, the length of the pattern before it repeats may be so long we have trouble seeing it, but all of us can learn the rules which decide if a given string fits the pattern.

All primates understand regular expression patterns. Given "abababababa", they know the next character is a 'b'. One can debate whether this is truly understanding regular expressions, but cognitive scientists assume it is.

To understand the next set of more powerful grammar rules, we need to look at what strings cannot be represented by regular expressions. A language with only a finite number of strings is always regular, since we could just string other all the valid strings with the | operator. For any other language, the * operation is needed. Let us say this operator repeats the pattern P preceding it. Then the string can be presented as X P Y, where X and Y are finite strings, with one possibly empty. But by the nature of the * operator, X P P Y, X P P P Y and so on, are also valid for the language.

The pumping lemma says that every infinitely long string in a regular language can be broken up into an X P Y, such that X P* Y is in the language. Here X and Y are finite strings, with possibly one but not both, empty. If this does not work, the language is not regular.

This sounds abstract. To see how to apply it, consider the language of strings ab , aabb, aaabbb, aaaabbbbb,. . . . Let us take a . . . b . . . , with numbers of a and b equal. If we consider X to be the left a and Y the right b, and pump, we get a . . . b a b . . . , not in the language. We cannot pump the middle section since it causes an a to appear between two 'b's. The language is not regular.

15.2.2 Context free languages

The next step in the Chomsky hierarchy of grammar power is the context free language. A rule does not depend on the context of the sentence. That is, if a rule applies to part of a string, it has to do so independent of the remaining part of the string to the left and right. For this, the rules have to be of the form:

Nonhuman primates do not understand such languages. Some birds do understand the paired counting strings ab, aabb, . . . presented earlier.

We need to make the language more powerful to get beyond birds. After all bird-brained is an ancient expression. To see what languages are not context free, one has to resort again to the pumping lemma. In this case, the rules can be thought similar to the patterns of regular expressions. Some set of rules have to be repeated for an infinite string in a CFL. This set can be repeated more times to make new strings, still in the language. If that is not possible, the language is not CFL. We can show the triple-paired counting string abc, aabbcc, aaabbbccc is not CFL.

To get a more powerful style, we need to go beyond the pumping lemma. The pumping lemma works only if the pumping, the repetition, can be done over and over. If the repetition depends on the surrounding string, then this method no longer applies. After one repetition, the surrounding string has changed, and the rule may no longer be applied. This leads to the idea of a context-sensitive language.

15.2.3 Context sensitive languages

Space complexity bounded TM Not known if any other animal understands it. Computer scientists ignore CSLs because they take forever to parse (but can always be parsed).

15.2.4 Arbitrary languages

What if we take out all writes in a grammar? An arbitrary grammar is equal in power to a TM, and hence is the most powerful language we, humans, can describe. This last is not proven mathematically, but believed widely.

Phrase structure grammar, and equivalence to TMs We understand it.

15.3 What we can copy and change

15.3.1 Creating humans

Out in the organic world our power stays the same as in the silicon world. Humans create new beings with the computation power of a TM through natural mating, inexpensive and pleasing for men. However sex and growth in the womb can be bypassed in making babies.

An incubator can replace the womb. Current technology allows this only for embryos beyond a development stage but that restriction is technological and non fundamental. Egg and sperm mating in a test tube can replace sex. Egg and sperm can also be got rid of. Cloning can be used to reproduce. Today the egg is needed to clone but again there is no fundamental limit to doing it with just a stem cell since the DNA information to assemble an infant is present there.

Taking this a step further, DNA of any cell can be used to clone since they all contain same DNA. After that, one can assemble a cell—DNA and cytoplasm—from organic chemicals and replicate from it. Since organic chemicals are just like other chemicals, one could continue down this path and create a human cell directly from any basic element, say hydrogen, and grow it in a culture to become a baby. This basic element can be converted to other elements needed by nuclear fission and fusion. The required organic molecules can be created by combining elements. Molecular machines can combine organic molecules to create DNA and other parts of a stem or adult cell. Which can then be grown in a culture made similarly.

Finally pure energy can be utilized directly to create a human baby. Energy can be converted to matter. Pure energy can be converted first to the most elementary atom, the hydrogen atom. From this carbon, nitrogen, oxygen, sodium, phosphorus, iron and other elements can be made. With these, molecular machines can produce and hook up required organic molecules to create DNA strands and from there a full cell. Parallely a culture can be created in which DNA can grow to be an infant.

Rather than search for energy sources one could use the vacuum, which has mobilizable energy, at least in theory. In effect, one could put together a newborn just from the vacuum of space. By any definition this is creation from scratch. The practical difficulty hardly need be mentioned but there is no theoretic roadblock.

15.3.2 Modifying our biology

Humans can modify their biology. One could shape and size one's arm, foot, skull and other body parts while growing up. It is an ancient practice. For finer control one could modify DNA at embryo stage to create or change new or existing organs. The biology that supports the brain can be changed predictably. Our immune system can be enhanced to better protect ourselves from germs.

And yes, the sex drive can be removed from males. This would also mean removing male sex organs making males females minus the clitoris and reproductive organs. Reproductive organs can be removed as well to make a genderless being unable to give birth. Reproduction could then be in vitro (cloning or external molecular mixing of DNA, with growth in incubator) instead.

15.3.3 Travel at light speed

On a tangent, humans can transport themselves at light speed using quantum entanglement, proved as a concept in a lab. This method of transport couples endpoints together at the most fundamental scale ensuring any change, even at a micro scale, to one gets faithfully mirrored in the other. The item to be moved is first made to interact with one endpoint quantumly. A mixed up replica of this object will now be present on the other side. To unscramble this and build a quantum duplicate at the receiving end extra information about the object has to be sent. The transport time depends on how fast this can be done. As per physics that is limited by the speed of light.[‡] In effect an object, for example an entire human, can be moved at the speed of information travel. This is equivalent to traveling from the first point to the second since the item at the original location disappears.

15.3.4 Travel to the past

The past can be observed and inspected, something less radical than it sounds. The finite speed of light and all other forms of communication ensures this. Seeing ourselves in a mirror is seeing the recent past because the light rays seen by us started their journey nanoseconds ago.

One could take such an example further. Think of a mirror a million light-years away. It might take us millions of years to get it in place but once that is done it should be possible to look back a million years just by seeing an older earth reflected in the mirror.

‡ Contrary to what most believe, physics imposes no fixed speed limit for the universe. It imposes a variable limit, the speed of light. As per physics nothing may go quicker than light but light itself can be made to go faster than its standard vacuum speed. A solid, mainstream theory predicts it would go faster in a vacuum subject to the Casimir effect, mentioned briefly in section 15.3.5 on the facing page.

Humans are able to change the future. Though the statement sounds trivial, scientists often deny it. We will explore this in detail in chapter ?? on page ??.

15.3.5 Existing as a species forever

The universe is mostly vacuum. According to physics vacuum differs from a void, having an associated energy which can be put to work. Casimir effect is a phenomenon in which two smooth metal plates brought together are pulled closer by energy density, of empty space, reducing between them. Today the method inefficiently utilizes the vacuum but such a method exists proving we can tap this unlimited energy. Note the source is not affected by the accelerating ballooning of the universe which leaves matter sparse.

Projection of an eventual death of the universe ignores vacuum energy because modern-day physics has trouble dealing with it. Values predicted by quantum physics are off by a huge order of magnitude. Any analysis of the fate of the universe ignoring this rests on faith. Vacuum energy will dominate the far future and without knowing much about it there is no way to figure out how best it can be utilized. Casimir effect proves mankind can tap it. Which means the useful lifetime of the universe is unbounded and humanity can exist forever.

15.3.6 Mind power

Robotic extensions can be added to the nervous system at every point right till the brain. Telekinesis is acting at a distance by thought alone. This could be achieved by hooking to electrical signals sent from the brain through spinal nerves. Electronic gadgetry attached to the body can boost and broadcast the signal. Such a signal can do active work if focused and amplified. Microwave signals, for example, can heat things up. Theoretically telekinesis can be achieved.

15.4 What we can destroy

The power to repair ourselves gives us the power to self-destruct. It leaves us the power to injure ourselves deliberately. And to cut off our organs. To kill self. To kill others. To destroy our planet.

Mankind probably has the power to destroy the entire observable universe converting all matter to vacuum. This is due to the same vacuum energy issue. It has reduced over time. Physicists think a phase change has suppressed the energy. It is possible, although unproved, that such phase change can be reversed locally. Undoing it would release suppressed vacuum energy leading to the fabric of space expanding massively. Things would fly apart. If this is operated on a large-enough scale it could cause the entire observable universe to expand rapidly emptying out space. The last claim, unlike everything else before, lacks a solid theory base. But from our history it is fairly certain any energy source which can be tapped can be tapped to blow things up. A limitless source can destroy limitless. The above scenario looks the likeliest way to destroy us all and more.

16 Limits of our power

At this point you might believe our power is limitless. Or if limit exists that it cannot be discovered or explained. A being unaware of its limit is feasible. It has intuitive appeal as it gives us the latitude to ignore this issue.

However the path science has taken forces us to deal with this directly. Science is analytic and predictive with clear and concrete aims:

· To analyze reality from how basic blocks interact.
· Formulate rules for interaction to explain how things changed over time.
· Predict the way things will continue to change over time.
· Model with a single theory all reality including human thought and intelligence.

Will that attempt succeed? Likely yes, assuming we survive long enough to reach there. Trying to answer this also deepens our understanding of a unified framework and what all it can explain.

16.1 The standard framework of science

The basic framework of science rests on physics. All science reduces directly to physics or chemistry. Chemistry fundamentally reduces to physics. A science discipline which claims to be exempt from its laws is no longer science.

Physics uses different models at different scales. Each model approximates entities at that scale. In cosmology theories of relativity are the most used. The classical version governs how everyday objects behave. Quantum laws determine how the building blocks of matter and energy work.

The standard model of science starts roughly 14,000 million years ago, when the universe was condensed into a dense ball which expanded explosively. After a period the blowout slowed but never died out. Material condensed to form planet, star and galaxy. Gravity forced planets to revolve around stars. Planet Earth was formed about 9000 million years later. Conditions on earth, or foreign matter injected by comets and asteroids, caused a bunch of chemical molecules to combine into organic molecules about 1500 million years ago. Organic molecules consist mainly of carbon, hydrogen, and oxygen, and are usually bigger than other molecules. Eventually they combined to form the DNA molecule with nourishing material which allowed it to grow into cells. Early organisms had just one cell and split to reproduce. Environmental condition caused DNA to change further and multicellular organisms, and even more complicated organisms, came to be. All these modifications were governed by the laws of chemistry. Which obey the laws of fundamental physics.

The genetic code, DNA, is a long molecule with submolecules A, T, G, and C embedded in it. Since the submolecules can be present in any sequence, the combinations are many. The chain A, T, T, T, G, C, . . . would be a valid combination and T, T, G, C, C, C, A, A, Aa, . . . another. For humans half our DNA is present in the sperm and half in the egg. At conception the halves mate to form the full genetic code of the child. Nourishing material in the egg helps DNA form cells. Our DNA copies itself into every cell nucleus in our body. Genes, specific important sections in the DNA strand, have an external effect through proteins they create. Proteins are again strings, this time with twenty submolecules called amino acids at each position. They fold in three dimensions in myriad ways. Cell behavior depends on its proteins. Different cells make up our different organs including the brain.

The brain is seen an electrochemical mechanism made of connected cells called neurons. There are about 1000 million neurons with hundreds or thousands of connections each. Neurons communicate ejecting chemicals and also signal muscles electrically to relax or contract. Our senses such as eyes and the skin pick up light, sound, smell, taste, and the pressure and warmth of touch, convert it to electrical signals, and relay them to the brain by nerves. Thus the body is an electromechanical device controlled from the brain, whose structure and function are partly coded for in the original DNA formed when the mother conceived. Brain structure depends on environmental features as well. People learn what is taught and the lessons are recorded as neuronal connections.

In effect the end structure of the brain depends on original DNA and environmental input. Both DNA and environmental input obey laws of physics and chemistry. Our consciousness boils down to biology which reduces to chemistry and then to physics.

Physics uses math for its models and predicts by mathematically formulating what is being studied. Physics has used continuous math, that is integral and differential calculus, extensively for its models.

All math including the continuous version reduces to discrete math, which deals only with countable entities. Arithmetic with integers, colloquially called numbers, is the best example. Integers are the numbers 0, 1, 2, 3, . . . The word discrete implies entities here are countable.

What is non discrete? The standard example of a continuous quantity is a real number. Take the length of any fixed line. The length can be represented with arbitrary accuracy. It could be approximated to two decimal point or three or more. The true length can be represented only abstractly with a concept called a real number. To be perfectly accurate, such numbers often have infinite unrepeated digits.

It might come as a surprise all math reduces to the countable case. However this reflects on our ability to understand continuity than on the power of discrete math. Math handles a continuous value as a limit case digitally approximating it better and better.

In short discrete math underlies all science. It also underlies computation theory. Continuous computers are available but their model still uses this kind of math because there is no other we know.

16.2 Free will

Free will has been debated extensively by scientists, theologians, philosophers and professors. The popular view is science allows for no human free will. However the human mind cannot work off this hypothesis. If everything is scripted in advance nothing has meaning. One quickly dead ends whichever way one turns. Everybody who states ‘free will does not exist’ immediately starts to hem and haw and qualify the remark many ways. This trait is something all take for granted. It should not be denied unless there is no choice. If it does exist what happens with the standard framework?

This chapter will look closely at free will, exploring how its presence both enhances and limits our ability.

16.3 Where the power of math ends

The only way to fit free will in science is to show science can model, but not predictively explain, some entity. If this is shown, free will can be modeled tied to such an unexplainable thing. Since the standard framework builds on discrete math we need to dig up an entity discrete math can represent but is powerless to analyze or explain.

Representability is the ability to represent or model a system. For physics, representability comes as equations. For discrete math this comes as a statement with a value. Explainability is the ability to use the representation to predict. In physics, a model equation is explained by solving it, exact or approximate. In discrete math a statement is explained by determining its exact value.

Discrete math statements have values. This follows from how a statement is constructed. Explainability and representability look the same here. However I will prove this is not so. There are 'representable' statements which are 'unexplainable'. To see this let us first look at the basics of discrete math.

16.3.1 Basics of discrete math*

In following sections I will avoid mathematical terms and use English words. Those familiar with logic should have no trouble mapping back to jargonese. I will also examine a system more general than the standard true and false one. This might be more intuitive to somebody unfamiliar with logic.

Discrete math allows us to write statements. Each statement has a value. A statement value is distinct from variable value. The system has a set of starting statements called axioms with fixed values. The assumption is these are known from direct observation or from some self-evident fact. Discrete math also has generation rules which combine statements to generate new ones. The generation rules do two things:

tell us the value of the new statement from its components, and
restrict us in how to combine component statements.

If we use truth value in place of value, restrict values to 0 and 1, have all axioms be of value 1, replace generation rule by the term inference rule, and define inference rules to be valid only if component statements are 1, we get the terms and system more used in mathematics. These restrictions have practical use, but without extensively discussing the practical aspect they will look unnatural.

Statements, also called sentences, are what basically constitute a DMS (Discrete Mathematical System). To represent something in a DMS is to write it as a DMS sentence. A sentence is 'explainable' if we can figure out its value from its structure, the axioms and the generation rules. As an example consider the system with axioms 'it rained yesterday' and 'if it rained yesterday, I will buy an umbrella tomorrow,' both having generated value true. Let there be a generation rule which combines two sentences of the form —'if statement1 then statement2' and 'statement1', both having value true. Let the generation rule produce the true statement 'statement2.' Applying this rule of generation to axiom1 and axiom2 we can write a new true statement 'I will buy an umbrella tomorrow.'

A sentence consists of constants, variables and operators. The values a variable may have, that is symbols corresponding to variable values, are termed constants. It is also convenient to have symbol 0 be a constant, to represent number 0. Variables have varying values and will be denoted with such symbols as $x, y, \ldots$ They may take any integer value. To use an informal analogy from English, in the sentence 'x is equal to 3,' x is a variable, 3 is a constant and 'is equal to' is an operator. The truth of this sentence cannot be tested unless we know what x is. That is the nature of a variable. Its value is unknown beforehand. When doing some manipulation it might end up with one, and then the truth of the statement can be determined.

Variables have an 'order.' Order 1 variables may take on a number value. If $x1$ is an order 1 variable, $x1$ may have a value such as 0, 7 or 35. Order 2 variables take sentences as their values. If $x2$ is an order 2 variable it may have as a valid value the sentence '$1 + 2$' or the sentence '$x1 + y1$.' Order 3 and higher order are hard to grasp intuitively—we will need them only in the abstract. Order number will be encoded directly in the variable name ($y2$, for example, would be an order 2 variable).

Operators join substatement operands. Single operators modify a single substatement to generate a new statement. Double operators join two substatements. There are strict, well-defined rules which dictate the value of the new statement. These rules are defined for every combination of substatement values. Since a statement consists of operator and substatement, value of substatements decides the value of the statement. Substatement value can be figured out by applying this scheme again to it. The scheme is repeated until parts left are axioms, which have a defined generated value.

This rule is only approximate. A general statement is not guaranteed to have a value. Consider the English analogy: '$x1$ is equal to 3.' This statement is valueless because it has an open variable. Let us call such statements parametrized statements, with variables the parameters. Statements with no open variable will be termed full statement or just 'statement' when context is clear. Full statements should have a value. How do we convert parametrized statements to full statements? There are two ways.

The first is to replace the variable by a number using the substitute operator (predicate). This operator operates on three operands —the first is the parametrized statement, the second the variable to be substituted, and the third the number value to substitute. It creates a new statement. If the original parametrized statement had only one open variable, the new statement is a full statement. Otherwise it is parametrized with one less open variable.

The second method uses a new set of operators called quantifier operators. Consider the modified forms 'for every value of $x1$, $x1$ is equal to 3' and 'there exists a value of $x1$, such that $x1$ is equal to 3.' The first statement is false in the English sense and the second true. The two new phrases 'for every value of' and 'there exists a value such that' are called quantifier operators. We will shorten these two as 'for all x' and 'there exists x <some-condition> such that <something>.'

With parametrized sentence and quantifier, value of a sentence is no longer fully specified by the value of its substatements. For a full statement created with quantifier and substitution, substatements are valueless. Our original scheme of figuring out statement value fails. To get a workable scheme I will introduce the idea of a generation tree. This requires the concepts of axiom and generation rule be made more concrete.

16.3.2 Axioms and generation rules*

Axioms are self-evident facts. Self-evidence is, however, ambiguous. For any system a set of principles needs to be followed to have axioms represent reality. The same applies to generation rules as well.

The most basic principle is axiom and generation rule be testable for valid syntax. There should be a way to see whether a statement is an axiom and whether a generation rule applies to a given set of statements. To ensure this axioms are usually limited to following kinds of DMS sentences (in these instances you are urged to focus solely on the DMS sentence structure and ignore its meaning):

· A straight DMS sentence (as an example, there exists x such that $[x < 30]$).
· A set of sentences, say $Q2$ implies ($R2$ or $S2$), with $Q2$, $R2$ and $S2$ second order variables which may represent any sentence. A sentence S belongs to this set if it is of the form 'A implies (B or C)'. This representation is called a sentence schema.
· A set of sentences, and further sets created by raising the order of variables. As an example, for all F, there exist X, Y such that $F(X)$ has value val1. Here F should have order one greater than X. One could start with order 1 (X order 1, and F order 2) and get a set. Then order can be changed to 2 (X with order 2, F with order 3) and we get another set. And so on.
· A set of sentences, and further sets created by substitution.
· Any of the above sets with arbitrary conditions on the order of each variable and on 'free'dom of variables.

Any DMS symbol sequence can be classified an axiom or otherwise, with the above rules.

For generation rules similar conditions apply. The rules should combine only a finite number of sentences to generate new sentences.

16.3.3 Generation tree*

A generation tree generates statements with a specific value. For each value we need a separate tree. Consider a system with two axioms—axiom1 having value value1 and axiom2 with value2. With two generation rules, rule1 and rule2. Rule1 generates a statement with value1 if all parts are of value1. Rule2 produces a statement with value2 if all parts have value2. The specifics of axiom and generation rule are immaterial.

A generation tree for value1 would have axiom1 as its start point. Branches will be sprung using rule1. Axiom1 might be repeated in the generation tree by combining it with an existing node using rule1 and generating a new node. A statement S has value value1 if it can be written as the last node, a leaf, of a generation tree for value1. See figure 16.1 on the facing page for an example generation tree for an axiom and generation rule set.

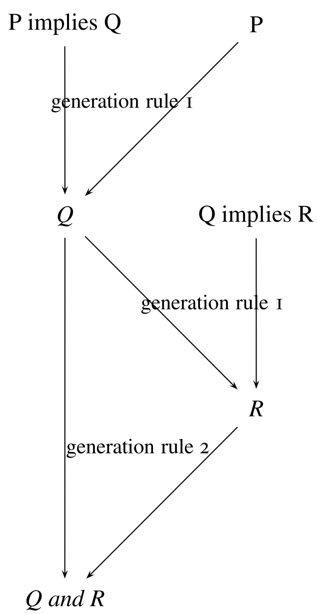
The notation BranchLeaf(*Branch*, *Y*) will be used to indicate statement *Y* is a leaf of *Branch*. For *Y* to be explainable it has to be the leaf of some branch of a generation tree. *Y* could be the leaf of more than a branch, but the branches should belong to the same generation tree, representing the same discrete value. The value of *Y* is the discrete value of the generation tree owning the branch. This means *Y* is derivable from a subset of axioms with that value by repeatedly applying generation rules which generate the value.

16.3.4 Incompleteness*

The pieces are now in place. The system looks powerful and consistent. Is it complete? Does every valid sentence have a generated value? Will this language explain every sentence it can represent? Reduction of human consciousness to laws of physics and from there to discrete math, along with the presence of free will, should make us suspect not. An individual could be represented as a physical model and reduced to a discrete math statement. Can we explain that statement? The day this can be answered by trying out the experiment is far off. Unless we change our societies dramatically that day will never dawn.

What choice exists? Is there another way to show this system can represent unexplainable sentences? Turns out there is. Gödel proved it by writing an incomplete statement. The following part synthesizes his statement in accurate detail. The proof is easier understood in reverse. We will first see abstractly the form of the statement. Then we will go deeper into how to write one.

The crucial insight is of self-reference. Sentences of the type 'I have such and such a property' are prime candidates. Examine the sentence 'I am true.' Is it true or false? Could be either. In natural language such ambiguity is aplenty. Uninteresting. Twist the



Axioms:
- P implies Q
- P
- Q implies R

Generation rules:
- ‘A implies B’ and A combined to generate B
- A and B combined to generate ‘A and B’

Figure 16.1: Value1 generation tree for ‘Q and R’

statement a bit: 'I am false.' True or false? If true then according to what the statement says it is, well, false. If false then what it says is actually true. Both ways what we conclude opposes what we assumed. This statement is self-contradictory without a true or false value. Statements of this type are called liar paradoxes. We will write a liar paradox in discrete math.

A statement can refer to another if the second is mapped to some other realm, say numbers. The map needs to be two way. The scheme should uniquely map a sentence to a number and back. Not all numbers need represent sentences. We should also be able to get full sentences out of parametrized ones by substituting a number for a variable. Each sentence, full or otherwise, now has a number associated with it, called its Gödel number. This is generated by the mapping method. What happens if a variable in a parametrized sentence is replaced with the Gödel number of that sentence? Well, nothing. We just get a new sentence of the form Substitute(n, 'y', Map(n)) with n being the original sentence, y the variable substituted, and Map(n) the Gödel number of sentence n.

A self-reference statement that is self-contradictory is written in our system the same way as in the liar paradox.

$S1$: $S1$ does not have value true.

$S1$: There is no X such that TrueBranchLeaf(X, $S1$)

$S1$ states it does not have value true, since it is not the leaf of any generation tree with value true. What choice is there for $S1$? $S1$ is a Gödel number. It is the Gödel number of a self-reference statement. Self-reference statements normally take the form Substitute(n, 'y', Map(n)). We have:

$S1$: $S1$ is the Gödel number of Substitute(n, 'y', Map(n)) . . . . . (1)

We need to figure out what statement n is.

NEED TO FILL THIS PART OUT: HOW TO GET SELF-REFERENCE BY DOUBLE INDIRECTION.

$S1$ is undecidable since it mirrors the liar paradox.

$S1$ states it is the leaf of no TrueBranch X. One sees the liar analogy here—$S1$ is similar to the statement which says 'I am not true.' $S1$ has no value for the same reason. Whichever value we choose for it leads to a contradiction.

Details of the Map, Substitute and TrueBranchLeaf predicates now need to be filled in. The derivation interchanges sentences, variables and their equivalent Map numbers. We need to figure out what systems permit such usage.

16.3.5 Gödel mapping*

Mapping, as defined here, associates a unique number with every sentence. This is harder than it sounds. The central issue is to be certain only one sentence maps to a given number. Not all numbers have to represent sentences. As a start take the following crude mapping:
+ maps to 0
X maps to 1
Y maps to 10
What sentence does 1010 represent? It could be $X+Y$ or YY. There is no way to distinguish between the two. We could avoid this problem two ways: let each symbol have a fixed number of digits in its map or use a token delimiter. A token delimiter is a special symbol used to mark the boundary between mapped symbols. We could use 2 as a delimiter in the above instance. $X+Y$ would then be '1 2 0 2 10' and YY '10 2 10'.

Since symbols are infinite in number, a fixed number of digits fails to work. Token delimiters work but have drawbacks which will become clearer when we see what all the map is used for.

The trouble is there is no unique way to decompose our number without introducing fixed-size blocks or delimiters. Leading to the question—is there a way to uniquely recover constituents of a built-up number? This depends on how the composite number is made. We looked at running together numerals of component numbers. We could instead opt to combine numbers arithmetically, say by adding them. But the same problem persists. The composite number can be additively split up multiple way. As an example, 3 and 4 would generate 7, but so would 1 and 6. What about multiplication? Again, 2×10 and 4×5 generate the same number.

Let us look closer at the issue here. With 7, we have $3 + 4 = 7$. But 3 can again be split with the + operator as $1 + 2$. We are putting together 3 numbers (1, 2, 4) with the + operator. We cannot map that back to 2 numbers since 3 numbers can be combined into 2 variously ($1 + 2$ and 4, or $1 + 4$ and 2, or 1 and $2 + 4$). For this operator to reversibly combine numbers, the original numbers should be undecomposable with it. Only one, 0, has that property.

Similar logic applies to multiplication. For $\times$ to be usable the original numbers should be indivisible by any other except 1. Many fit this requirement—1, 2, 3, 5, 7, 11, 13, 17, . . . Such numbers are called prime numbers. To uniquely decompose the composite number, our only requirement is numbers used to build it up be prime. Basic symbols need to be mapped to primes to guarantee this.

Once numbers are assigned to basic symbols we could map a statement as the product of numbers which represent its symbols. Such a number is uniquely split into components by factorization. For example, $8 = 2 \times 2 \times 2$ and $30 = 3 \times 2 \times 5$. Breaking up a number into its smallest multiplicative factors is factorization.

Now you have an intuitive idea how to map a sentence to a number and back, let us consider a system close to Gödel's. The system is complicated by having to map an arbitrary number of variables of arbitrary order.

The basic constants and operators are mapped as follows:

0:	2	successor:	3	not:	5	or:	7
and:	11	imply:	13	equivalent to:	17	for all:	19
there exist:	23	(:	29	):	31	[:	37
]:	41	{:	43	}:	47		

The operators chosen here—not, or, and, imply, equivalent to, for all, and there exist—are the ones useful to us. 'Not' switches the discrete value of its argument to the next value cyclically. 'Or' gives us a value true if either or both operands have value true. 'And' gives us a value true only if both operands have value true. *X* implies *Y* is the same as 'if *X* has value true then *Y* has value true'. The value of '*X* implies *Y*' is true, if *X* does not have value true, or if both *X* and *Y* have value true. *X* equivalent to *Y* is the same as (*X* implies *Y*) and (*Y* implies *X*).

In Gödel coding, each variable of order *n* is associated with a prime number of the form $p \times p \times p \times \cdots n$ times (normally denoted p^n). Variables of order 1 would be associated with such numbers as 53, 59, 61 . . . , variables of order 2 would have such numbers as 53^2, 59^2, 61^2 and so on.

Once a number is assigned to each symbol in a sentence, these numbers *n1, n2* . . . *nk* are combined to form the number $2^{n1} \times 3^{n2} \times \cdots \times p_k^{nk}$, where p_k is the *k*-th prime number. This number would be the Gödel number for the sentence. Here the notation 3^2 represents the value 3×3.

We will take this a step further and combine sentences the same way. If sentence *S1* has number *n1*, and sentence *S2* number *n2*, then sentence sequence *S1 S2* has Gödel number $2^{n1} \times 3^{n2}$.

It is easy to verify the decomposition is again unique. The breakup here is two part. The first recovers individual numbers as the times each prime repeats in the factorization. Thus Gödel number 72 factorizes to $2 \times 2 \times 2 \times 3 \times 3$. The constituent numbers are 3 and 2 (2 repeats thrice and 3 twice). Which stands for symbol sequence 'successor 0'.

Constituent numbers are guaranteed to be a prime or a power of a prime (that is a prime multiplied by itself over and over). Variables of order greater than 1 generate powers of primes. The order of a variable is the times the prime repeats.

One final point. A number is written in this system using constant 0 and the successor function. For example, 2 is written as 'successor successor 0.' This statement can itself be converted to a Gödel number. Numbers can be converted to DMS statements which, in turn, can be converted to Gödel numbers.

16.3.6 TrueBranchLeaf predicate*

The predicate TrueBranchLeaf(*Branch*, *Y*) has the following logic:

check whether Branch has an axiom or axioms at its root,
check whether each succeeding statement on the branch follows from previous ones by a rule of generation,
check whether the last node in the branch is *Y*,
if all conditions pass, then return value true, otherwise return some (any) other value.

Substitute(*x*, *y*, *z*) has simple logic—just substitute number *z* for every occurrence of variable *y* in sentence *x*. In theory the same variable name (such as *y*) can be used to indicate different variables in the same statement. In practice one could rename variables to get an equivalent statement with unique names.

The issue left is to write DMS sentences to implement the logic of Map, Substitute and TrueBranchLeaf. Note these predicates work on numbers. TrueBranchLeaf(*Branch*, *X*), for example, takes two Gödel numbers and checks if they are numerically related. The first is the sentence sequence representing the branch and the second the sentence whose generated value we are trying to find. Substitute works similarly. It takes three Gödel numbers—one each for sentence, variable and value. It generates a new Gödel number, that of the sentence which has the open variable replaced by the value. Again only numbers are worked with.

Axioms and generation rules should be chosen to make the system powerful enough to do such calculation. There are interesting systems lacking this power, the most notable being geometry. But we should remind ourselves our starting point. We are interested in mathematically describing a physical model of an individual, including the brain. Such a description should be able to do the manipulation mentioned.

A system called PRA (Primitive Recursive Arithmetic) is enough for this proof. Any system that strong or stronger will be incomplete. To see what functions PRA contains, we will first assume it has standard arithmetic operators (+, ×, ÷, repeated multiplication and comparison operators—equal, not equal, less than, greater than, greater than or equal, and less than or equal), and write Map(x) and Substitute(x, y, z) and see what else is needed. Our axioms and generation rules will be chosen based on this need. If those axioms and generation rules can themselves be checked the same way, the self-referencing TrueBranchLeaf statement can be written in the system. More axioms and generation rules will lead only to a new TrueBranchLeaf statement, as long as they conform to principles laid out in section 16.3.2 on page 317.

We will now build DMS statements, for all predicates discussed, as primitive building on preceding primitive. A primitive is just notational shorthand for the definition that succeeds it.

16.3.7 Map predicate*

The Map predicate maps a number to its Gödel number. Thus Map(3) would be the Gödel number corresponding to 'successor successor successor 0' which is $2^3 \times 3^3 \times 5^3 \times 7^2 = 8 \times 27 \times 125 \times 49 = 1323000$.

1. ***x* DivisibleBy *y*** There exists z less than or equal x, such that x equals $y \times z$

   This primitive illustrates the technique of search on which the construct rests. It tests if x is divisible by y by stepping through every number from 0 to x and checking whether x is the product of the step-number and y. The step is represented by z. The primitive searches through all combinations to check for a solution. For this to work the number of such combinations should be bounded and it should be possible to figure out the bound. Once we get to number x the search stops since x can never be the product of a number still greater whatever be the second factor.

The search needs a fixed order so it does not repeat. The order is to start from 0 and count up. Ordered, bounded search of this kind uses the there exist quantifier, with a less than or less than or equal condition on the variable. Order is implicitly assumed to ascend from 0.

2. **IsPrime $\boldsymbol{x}$** (x greater than 1) and (there exists no z greater than 1 and less than x such that x DivisibleBy z)
3. **PrimeFactor(0, $\boldsymbol{x}$)** 0
   PrimeFactor($\boldsymbol{n}, \boldsymbol{x}$) That value of y less than or equal x such that [IsPrime y] and [x DivisibleBy y] and [y greater than PrimeFactor($n - 1, x$)]

   PrimeFactor(n, x) is the n^{th} (by size) prime number contained in x. So, with 315 ($3 \times 3 \times 5 \times 7$), PrimeFactor(1, 315) is 3, PrimeFactor(2, 315) is 5, PrimeFactor(3, 315) is 7 and PrimeFactor(4, 315) is 0 since a failed search returns 0.

   This predicate introduces recursion. As for IsPrime, we could find the first factor by walking from 0 onward till a number which divides into x. This is what the first two parts do. The scheme works for the n equals 1 case. But for n equals 2 when we restart the walk we need to skip the first factor. For this the search should continue till a number larger than the first factor meeting all other criteria. For n equals 3, similarly, the search should get to a number larger than PrimeFactor(2, x), the second factor. In general for PrimeFactor(n, x), the search should keep going till it gets to a number greater than PrimeFactor($n - 1, x$). The last check is for this. PrimeFactor(n, x) is now specified through PrimeFactor($n - 1, x$). This is recursion. PrimeFactor(0, x) equals 0 terminates recursion by removing the restriction for PrimeFactor(1, x). You should walk through a few instances to understand recursion.
4. **0!** 1
   ($\boldsymbol{n}$ + 1)! $(n + 1) \times n!$
5. **($\mathbf{n^{th}}$Prime) 0** 0
   $\mathbf{n^{th}}$Prime $\boldsymbol{n}$ + 1 Value of y less than or equal [($\mathrm{n^{th}}$Prime n)! +

1] such that [(IsPrime y) and (y greater than n$^{\text{th}}$Prime(n))]

Predicate n$^{\text{th}}$Prime(n) is the n^{th} (by size) prime number. The bound here is interesting. For every prime number p there is always a larger prime. And this larger number is always less than or equal to $(1 \times 2 \times 3 \times \cdots \times p) + 1$. To see why, think of prime factors of the number we wrote. This number cannot have a number less than p as its factor, since dividing by any less than p would leave remainder 1. So this number is prime and cannot be factored or its factors are prime and larger than p. In both cases we have found a prime between p and this number.

6. **(Item *n x*)** Value of y less than or equal x such that {[x DivisibleBy PrimeFactor(n x)^{y}] and [x not DivisibleBy PrimeFactor(n x)$^{y+1}$]}

   This predicate extracts the Gödel number of the n^{th} item. Thus, with $n = 280 = 2 \times 2 \times 2 \times 5 \times 7 = 2^3 \times 5 \times 7$, we have (Item 1 280) = repeat factor for 2 = 3; (Item 3 280) = repeat factor for 7 = 1.

7. **NumberOfItems(*x*)** Value of y less than or equal x such that {[PrimeFactor(y x) greater than 0] and [PrimeFactor($y + 1$ x) equals 0]}

   NumberOfItems(280), for example, is 3 (3 unique factors present—2, 5 and 7).

8. $\boldsymbol{x \bullet y}$ Value of z less than or equal [n$^{\text{th}}$Prime(NumberOfItems(x) + NumberOfItems(y))]$^{x+y}$ such that {[for all n less than or equal NumberOfItems(x) [Item(n z) equals Item(n x)]] and [for all n greater than 0 and less than or equal NumberOfItems(y) [Item(n + NumberOfItems(x) z) equals Item(n y)]]}

   Operation $x \bullet y$ corresponds to linking sequences. Let x correspond to ‘successor’ and y to ‘successor 0’. Then $x \bullet y$ should correspond to ‘successor successor 0’. In numeric terms x has value $2^3 = 8$ and y value $2^3 \times 3^2 = 8 \times 9 = 72$. The composite $8 \bullet 72$ has value $2^3 \times 3^3 \times 5^2 = 8 \times 27 \times 25 = 5400$. Corresponding to number sequence 3, 3, 2 which represents symbol sequence ‘successor successor 0’.

9. **seq(*x*)** 2^{x}

10. **n$^{\text{th}}$Successor(0 *x*)** x

    n$^{\text{th}}$Successor(*n* + 1 *x*) seq(3) • n$^{\text{th}}$Successor(n x)

    Number 3 stands for the constant function successor. Hence nthSuccessor(2, seq(2)) would be seq(3) • seq(3) • seq(2) which is successor successor 0. This corresponds to number 2 in arithmetic.

11. **Map(x)** nthSuccessor(x seq(2))

16.3.8 Substitute predicate*

The Substitute predicate is easier to derive on top of a ValidSentence predicate. The ValidSentence predicate checks whether a number is the Gödel number of a statement. In the next section we will actually derive this predicate.

The Substitute predicate replaces free occurrences of a variable in a sentence with a value. A free occurrence is one free from a constraining for all or there exist operator. This last check is covered by intermediate predicate WithinAQuantifier.

12. **VariableOrder(n x)** There exists z greater than 47 and less than or equal x such that {IsPrime(z) and (x equals z^n) and (n not equals 0)}

    This predicate is true only if x is order n.
13. **IsVariable(x)** There exists n less than or equal x such that {VariableOrder(n x)}
14. **bracket(x)** seq(29) • x • seq(31)

    The number 29 corresponds to '(' and 31 to ')'.
15. **squareBracket(x)** seq(37) • x • seq(41)
16. **brace(x)** seq(43) • x • seq(47)
17. **ForAll(x y)** seq(19) • seq(x) • bracket(y)

    The above translates roughly to for all x (some statement y). ForAll2 and ForAll3 should be defined similarly using squareBracket and brace instead of bracket.
18. **ThereExists(x y)** seq(23) • seq(x) • bracket(y)

    ThereExists2 and ThereExists3 should use squareBracket and brace in place of bracket.
19. **WithinAForAll(v, n, x)** IsVariable (v) and ValidSentence (x) and there exist a, b, c less than or equal x such that {[x equals a • ForAll(v, b) • c] and ValidSentence(b) and [(NumberOf Items(a) + 1) less than or equal n less than or equals NumberOf Items(a) + NumberOfItems(ForAll(v, b))]}

    This predicate checks whether n^{th} item of sentence x is within a for all quantifier binding variable v. To be complete, it should check for ForAll2 and ForAll3 similarly.

20. **WithinAThereExists(v, n, x)** IsVariable (v) and ValidSentence (x) and there exist a, b, c less than or equal x such that {[x equals a • ThereExists(v, b) • c] and ValidSentence(b) and [(NumberOfItems(a) + 1) less than or equal n less than or equals NumberOfItems(a) + NumberOfItems(ThereExists(v, b))]}

    ThereExists2 and ThereExists3 should also be checked for, with the 3 checks 'or'-ed together.
21. **WithinAQuantifier(v, n, x)** WithinAForAll(v, n, x) or WithinAThereExists(v, n, x)
22. **Free(v, n, x)** IsVariable(v) and ValidSentence(x) and v equals Item(n, x) and n less than or equals NumberOfItems(x) and not WithinAQuantifier(v, n, x)
23. **FreePlace(0, v, x)** Value of n less than or equal NumberOfItems(x) such that Free(v, n, x)

    FreePlace(k + 1, v, x) Value of n less than or equal NumberOfItems(x) such that {[n greater than FreePlace(k, v, x)] and Free(v, n, x)}
24. **NumberOfFreePlaces(v, x)** Value of m less than or equal NumberOfItems(x) such that FreePlace(m, v, x) equals 0
25. **Replace(x, n, y)** Value of z less than or equal [nthPrime(NItems(x) + NItems(y))]$^{x+y}$ such that {there exist u, v both less than or equal x such that x equals u • seq(Item(n, x)) • v and z equals u • y • v and n equals [NumberOfItems(u) + 1]}

    NItems is shorthand for NumberOfItems. Replace predicate replaces n^{th} item of x with value y.
26. **SubstituteFreeOccurrences(0, x, v, y)** x

    SubstituteFreeOccurrences(k + 1, x, v, y) Replace(SubstituteFreeOccurrences(k, x, v, y), FreePlace(k, v, x), y)
27. **Substitute(x, v, y)** SubstituteFreeOccurrences(NumberOfFreePlaces(v, x), x, v, y)

    This definition substitutes free occurrences of v in sentence x with value y.

16.3.9 ValidSentence predicate*

The ValidSentence predicate checks with bounded search if a number is the Gödel number of a sentence. Sentences are built from elementary items through operators and can be connected with operators to generate more sentences. Such sequences are represented by number sequences in our mapping scheme. The ValidSentence predicate checks whether its argument Gödel number is the last of a sequence, exhaustively searching all such.

28. **Not(x)** seq(5) • bracket(x)

    Number 5 stands for 'not'. Here we ignore square bracket and brace, since they are not strictly necessary.

29. **Or(x y)** bracket(x) • seq(7) • bracket(y)
30. **And(x y)** bracket(x) • seq(11) • bracket(y)
31. **Implies(x y)** bracket(x) • seq(13) • bracket(y)
32. **EquivalentTo(x y)** bracket(x) • seq(17) • bracket(y)
33. **ParametrizedSentenceOfOrder1(x)** There exist m, n both less than or equal x such that {[m equals 2 or VariableOrder(1, m)] and x equals n$^{\text{th}}$Successor[n, seq(m)]}

    A sentence of the form successor(successor(x)), with x a normal variable or 0, is a parametrized sentence of order 1 with parameter x.

34. **ParametrizedSentenceOfOrderN(n, x)** [n equals 1 and ParametrisedSentenceOfOrder1(x)] or {n greater than 1 and there exists v less than or equal x such that [VariableOrder(n, v) and x equals seq(v)]}
35. **ApplicationOperation(x)** There exist y, z, n all less than or equal x such that {ParametrizedSentenceOfOrderN(n, y) and ParametrizedSentenceOfOrderN(n + 1, z) and x equals [z • bracket(y)]}

    This is an additional operation allowed in DMS sentences. Sentences of type $F(x)$, F being a parametrized sentence and x a variable, is the easiest to understand (n is 1 for this case).

36. **Operator(x, y, z)** [x equals Not(y)] or [x equals Or(y, z)] or [x equals And(y, z)] or [x equals Implies(y, z)] or [x equals EquivalentTo(y, z)] or {there exists v less than or equal x such that [IsVariable(v) and [(x equals ForAll(v, y)) or (x equals ThereExists(v, y))]]}
37. **SentenceSequence(x)** For all n greater than 0 and less than or equal NumberOfItems(x) {ApplicationOperation[Item(n, x)] or [there exist p, q greater than 0 and less than n such that Operator[Item(n, x), Item(p, x), Item(q, x)]]}

    A sentence sequence is such a sequence as:

    $F(x)$
    $G(y)$

not $G(y)$
$F(x)$ or $G(y)$
$\{F(x)$ or $G(y)\}$
$\{F(x)$ or $G(y)\}$ implies not $G(y)$

The line breaks are for readability. First each line, a sentence, is mapped to a Gödel number. Then the number sequence is collected and mapped to another bigger number the same way. The predicate above checks whether the argument sequence is a valid construct, with each line built up from previous ones with standard operators.

38. **ValidSentence(*x*)** There exists n less than or equal $(\mathrm{n^{th}Prime}(\mathrm{NItems}(x) \times \mathrm{NItems}(x)))^{x \times \mathrm{NItems(x)} \times \mathrm{NItems(x)}}$ such that {SentenceSequence(n) and [x equals Item(NumberOfItems(n), n)]}. NItems is shorthand for NumberOfItems.

    Another ordered, bounded scan. To check whether a sentence is valid we check if it can be built up as a sentence sequence. A way to check is to build all sentence sequences and dig through them to see if any lead to the relevant one. That is, if their last line is our sentence. For this probing, the set of all sentence sequences should be ordered first. Ascending order is used. We start with Gödel number 0 and test if it is a valid statement sequence. If not the search goes to the next number. If a valid statement sequence is found its last item is matched against the sentence. A match signals the hunt succeeded. If the match fails the search continues with the next number.

    The search needs an end condition. A sentence sequence which satisfies our criteria is a stop condition since duplicates are ignored. If such a sequence is absent we should stop when no larger number works. Any sequence can be reordered so the last item is the longest. If a sequence has x as its last item every item has a maximal length NumberOfItems(x). There can be a maximum NumberOfItems(x) of such items as any more would be redundant. With this bound the last item has, as its base, the maximal value $\mathrm{n^{th}Prime}$(NumberOfItems(x) × NumberOfItems(x)). The superscript bound is derived similarly.

16.3.10 The PRA system*

The derivation used statements of the form 'the value of y such that y less than ...' and 'there exists a y less than ...' to do ordered, bounded search. It also used recursive definition. Axioms and generation rules for the system should be defined to allow recursive and bounded scans. The number relations such a system can express should include those implied by search and recursion.

Axiom sets defined in accord with the principles in section 16.3.2 on page 317, able to handle arithmetic, will allow writing Map, Substitute and TrueBranchLeaf predicates. We will illustrate this for an axiom set. It is tedious to prove this set can handle arithmetic. Adding more axioms is definitely enough. From examples below it should be clear such a more powerful system will be constructionally incomplete for similar reason.

16.3.10.1 Peano axioms*

Peano axioms generate numbers. There are three basic axioms:
Number 0 is the successor of no other number.
If two numbers have equal successors the numbers are equal.
If a property, any property, holds for 0, and if we prove the following: *If a number has the property its successor has the property as well* then the property holds for all numbers.
An axiom needs no proof but intuitively this can be justified as follows: If a property holds for 0, by the italic section it holds for 1. If it holds for 1, again by the italic section, it holds for 2. Arguing this way it holds for all numbers.

Writing in mathematical language:

1. There exists no x such that successor(x) equals 0
2. (Successor $x1$) equals (successor $y1$) implies $x1$ equals $y1$
3. For all $x2$
   if ($x2$ 0) and for all $x1${($x2$ $x1$) implies [$x2$ (successor $x1$)]}
   then for all $y1$($x2$ $y1$)

Note: x implies y is the same as 'if x then y'.

39. **PeanoAxiom(*x*)** (x equals Pa1) or (x equals Pa2) or (x equals Pa3)

    Pa1, Pa2 and Pa3 are Gödel numbers corresponding to Peano axioms. Note these axioms are directly converted to numbers with our mapping.

16.3.10.2 The other axioms

Logic axioms

Every statement created inserting arbitrary statements for p, q

and r in the following schema:
p or p implies p
p implies (p or q)
(p or q) implies (q or p)
(p implies q) implies ((r or p) implies (r or q))

40. **Logic1Axiom(x)** There exists y less than or equal x such that ValidSentence(y) and x equals Implies(Or(y, y), y)
    Logic2Axiom (x), Logic3Axiom (x) and Logic4Axiom (x) are defined similarly.
41. **LogicAxiom(x)** Logic1Axiom(x) or Logic2Axiom(x) or Logic3Axiom(x) or Logic4Axiom(x)

Substitution axioms Another schema:
(For all v y) implies Substitute(y, v, z)
{[For all v (p or q)] implies [p or (for all v q)]}
with v a variable, y and q statements, p a statement without an open variable v, z a statement of same order as v, with the requirement z not contain a variable that would be bound in a position in y where substitution happens.

42. **SubstitutionAxiomCondition(z, y, v)** Not there exists n less than or equal NumberOfItems(y), m less than or equal NumberOfItems(z), w less than or equal z such that {w equals Item(m, z) and WithinAQuantifier(w, n, y) and Free(v, n, y)}
43. **SubstitutionAxiom1(x)** There exist v, y, z, n less than or equal x such that {VariableOrder(n, v) and ParametrizedSentenceOfOrderN(n, z) and ValidSentence(y) and SubstitutionAxiomCondition(z, y, v) and x equals Implies(ForAll(v, y), Substitute(y, v, z))}
44. **Free(v, x)** There exists n less than or equal NumberOfItems(x) such that Free(v, n, x)
45. **SubstitutionAxiom2(x)** There exist v, p, q less than or equal x such that {IsVariable(v) and ValidSentence(p) and not Free(v, p) and ValidSentence(q) and [x equals Implies(ForAll(v, Or(p, q)), Or(p, ForAll(v, q)))]}

Comprehension axiom Inserting any variable for v, a variable an order higher for u, and a statement with no open variable u for y:
There exists u such that {for all v[u(v) equivalent to y]}

46. **ComprehensionAxiom(x)** There exist u, v, y, n all less than or equal x such that {VariableOrder(n, v) and VariableOrder($n+1$,

u) and not Free(u, y) and ValidSentence(y) and x equals ThereExists[u, ForAll(v, EquivalentTo(seq(u) • bracket(seq(v)), y))]}

Extension axiom

For all $x1$ {[($x2$ $x1$) equivalent to ($y2$ $x1$)] implies ($x2$ equals $y2$)} or a sentence formed from this by an order lift, that is by increasing the order of each variable by 1.

47. **RaiseOrderOfVariables(n, x)** Value of y less than or equal $x^{\mathrm{x \times x \times} \cdots \mathrm{n\ times}}$ such that {for all k less than or equal NumberOf Items(x) [[(Item(k, x) less than or equals 47) and (Item(k, y) equals Item(k, x))] or [(Item(k, x) greater than 47) and (Item(k, y) equals Item(k, x) × PrimeFactor(1, Item(k, x))$^{\mathrm{n}}$)]]}
48. **ExtensionAxiom(x)** There exists n less than or equal x such that x equals RaiseOrderOfVariables(n, EA)

EA is the Gödel number for the Extension axiom.

16.3.10.3 The generation rules

The only generation rules we need are the implication rule and the vacuous generalization rule:

If z and z implies x both have value val1, x has value val1.

If y is a full statement with value val1, for all v{y} has value val1 for any variable v.

49. **TrueGenerationRule(x, y, z)** [y equals Implies(z, x)] or there exists v less than or equal x such that {IsVariable(v) and [x equals ForAll(v, y)]}

16.3.11 The TrueBranchLeaf statement

With preceding notational definitions the predicate is now straightforward.

50. **IstrueAxiom(x)** PeanoAxiom(x) or LogicAxiom(x) or SubstitutionAxiom1(x) or SubstitutionAxiom2(x) or ComprehensionAxiom(x) or ExtensionAxiom(x)
51. **IsAValidtrueTree(x)** (NumberOfItems(x) greater than 0) and for all n greater than 0 and less than or equal NumberOf Items(x) {IstrueAxiom[Item(n, x)] or there exist p, q greater than 0 and less than n such that TrueGenerationRule[Item(n, x), Item(p, x), Item(q, x)]}
52. **TrueBranchLeaf(X, Y)** IsAValidtrueTree(X) and [Item(NumberOfItems(X), X) equals Y]

TrueBranchLeaf(X, Y) can be written for any axiomatic system if it handles logic and integer arithmetic, and axiom and generation rule conform to section 16.3.2 on page 317. From this self-referential statement we can derive an incomplete statement. As a result an axiomatic system of this kind has built-in incompleteness. Where incompleteness means the system can represent sentences it cannot explain. Equivalently it is unable to explain some sentence it can represent.

The arithmetical relation set used here is called the primitive recursive set. We will skip over primitive recursion. As stated before all that is needed is to ensure axioms generate functions used in the derivation. Axioms are always direct sentences or schema from which one gets sentences by substitution or order lift. Some such axiom combination is enough to generate primitive recursion. Such a combination exists and we have given it.

Primitive recursive functions can check whether a Gödel number is an axiom or a generation rule. The long, detailed derivation should convince you of this. In essence the system validates generation trees it creates. And it can search through generation trees until it finds one with the requested sentence as a leaf. This is the self-reference that leads to self-contradiction and predictive incompleteness.

16.3.12 Other discrete systems

Gödel's theorem applies to any discrete system powerful enough, informally one that handles arithmetic and integer relations. Models of interest to us belong to this class. The number of axioms, discrete output values, and generation rules is irrelevant. Infinite incomplete statements are present in any such model.

16.3.13 Applicability of Gödel's theorem

The Incompleteness theorem formalizes our intuitive notion a self-aware entity cannot understand itself completely. We showed this formally for a discrete math system to which all science reduces. However, physical models which reduce to a powerful enough discrete math system, and no further, are sometimes complete. It is the presence of free will, coupled with the Incompleteness theorem, that enables us to predict a physical representation of a human will have an unanalyzable aspect. Unanalyzability does not invalidate the standard model of science. We know and ignore it because our ability to reduce physical models to discrete math is still at a stage where this is a nonissue.

This does not mean Gödel incompleteness applies to humans. This theorem applies to mathematical model and method, not to a mathematically undefined entity like 'humans'. If that entity were to be defined with a math model the model would be Gödel incomplete. That shifts the question to whether this is intrinsic or from the technique. The presence of free will guarantees any predictive, analytic modeling method will be incomplete here. The only such method today provides for this in the Incompleteness theorem. Other methods might be invented in the future. Three possibilities exist—they will be proved complete, no proof will exist the system is complete or otherwise, or they will be proved incomplete. For the first case, we predict such systems would be inconsistent or unable to model physics because of recourse to unphysical constructs. The second case is probable since incompleteness proofs are hard to come by. However at some point the system will encounter an incomplete statement even with no prior proof of its presence.

16.4 Another look at free will

So far we referred to free will in the abstract. To better grasp this intuitively we will use analogy.

People have used three basic compact representations to work with their environment—the statistical model, the mechanistic model, and the trial and error model. I focused on the mechanistic one. In such a model free will is explained as the presence of an incompleteness. This can be made concrete with an analogy.

The mechanistic model thinks of humans as autonomous beings built from scratch autonomously following certain rules and initial settings. The nearest analog among our creation is a robot. A robot is a UM, from the viewpoint of computation power. As described before it can, in general, never predict another robot's output for an input. Nor can it figure out its own response to all input sets. From a robot's perspective it has free will, defined as a basic inability to predict behavior. From a robot's perspective other robots too have this quality.

Our free will is also of this nature. No person can ever predict another's response to all inputs deterministically or probabilistically. No one can predict their own response either. Which is what most mean by the word. I define the term as that which fundamentally blocks exactly predicting our behavior. This chapter shows how this is allowed for in standard science still leaving it consistent.

The as-if principle states if X appears as if it is Y and if in any analytic model we come up with, X will appear to be Y, then X is Y. In any analytic model, even a non predictive one, it will appear we have free will. By the as-if principle, people need to behave as if they have discretion to decide.

What about the other two schemes? Nobody has ever managed to apply statistics or trial and error to precisely determine how individuals behave. Assume somebody comes up with such a method. Those who know about it can first calculate their supposed behavior and do something else. Behavior can be statistically analyzed and predicted. However humans have the power to falsify that prediction. Computational undecidability and logic incompleteness are proven with a similar chain of reasoning. The proofs make self-aware predictive systems falsify what they predict to become indeterminate.

At least one reputed book bordering on philosophy and psychology claims all events, including free choice, are either deterministic or random accidents, and so voluntary choice is a myth. The randomness referred to is either 'random mutation' of evolutionary theory, or something more fundamental. If it refers to gene mutation it is misleading. At finer granularity the standard model disallows gene change being random. The macro laws of physics apply there. If something more fundamental is meant then this is just a play on words. Human free will can be explained as random since both refer to the same idea—unexplainability by a predictive system. Pure randomness, by definition, represents something science can model but not explain. Freedom to choose, when analyzed, will also be found to be pure random in part. That does not make it an illusion.

16.5 What we cannot do

A few things can be deduced to be past our limit because we are free-will incomplete:

· No way to change the past.

- Impossible to see into the future.
- Cannot go beyond our computation limit in a predictive fashion. ’[[4r
- No way to measure intelligence accurately, or to be sure how inexact any measure is.

16.6 Alternative definitions of free will

Psychologists have many definitions of free will. It is sometimes defined as spontaneous action in the absence of any sensory input. Such a state is not known to exist in any living brain; brains are always exposed to some stimuli, even in deep sleep or even a coma. In a coma, the brain still receives chemical, hormonal input, from the bloodstream, and this would be driven by physiological processes in the body. These processes, in turn, would depend on the body environment. A brain in isolation cannot exist. Theorizing on how something which cannot exist can behave is difficult.

Another definition ties it to volition, or conscious action. Here free will is thought to exist only if we consciously feel it. There are some studies which show our conscious feeling of making a choice comes after other brain modules have made the choice for us. This does not mean we have no free will. It just means the definition does not capture what people mean by freedom of choice. It looks like we manage to mentally feel, imagine or verbalize, our choices only after we have made them. Free will is tied to whether we can make choices, not whether we consciously remember our choices only after we have made them.

17 The Road Ahead: a Transitional World

God be between you and harm in all the empty places where you must walk.

Ancient Egyptian blessing

17.1 Theory

In the ideal world, innate nature would develop differently, leading to a society which cannot be destabilized by a few straying sometimes. However the transitional world will have people whose developmental phase is over. To begin with, they will be the only kind.

Per evolutionary psychology, the mind is made of processing modules, adaptations, which are calibrated by development, and take the social environment as input. The calibration would differ in the ideal world and the transitional world. The first generation to switch would be developmentally influenced by our current societies. In the outside world, they will be subject to negative emotions and attitudes. Neuroanatomically, emotions such as guilt and revenge will be hardwired in them.

As of now women are indeed brought up to balk at this idea. They develop a biological feeling to give sex, even if not innate, just as learned addictions drop biological anchors. From a brain chemistry point of view, the feeling appears as rooted as an inborn one. Studies have shown women are also attached more to kin. Most mothers would not part with their children. Those ties are expressed hormonally and hence whether they are learned is not material. How can such women be persuaded to switch? What can be learned can be unlearned. Unlike addiction, there is no unnatural chemical agent feeding the feeling; it flows from what is taught in childhood. We can flex to changing circumstances, based on rationally thinking of what is best for us. The reducing of stress will help cement the new way. The support of a tight-knit widely dispersed community guaranteed to be there for you, with both money and physical support of wants, should sell well. For children, a better life with fewer specific attachments is what our world promises.

Women naturally would be reluctant to switch since the change is more drastic and the bridges burned cannot be rebuilt. Building trust and a belief we will not leave them in the lurch, abandoning the transitional world midway, is a must. We should demonstrate how committed we are to this vision by never repudiating it when the shouting is the loudest or the shooting the sharpest. We should also take care not to apply the concepts chopped to the biases of the crude or the conservative, and convince women we are integrally dedicated to the full idea of an ideal world. That we are able and inclined to support them for childcare and money-related issues is to be driven home.

Jealousy will not exist among us because of our sharing way. Inputs that can trigger it cannot be present among us, by design. But jealousy, including sexual jealousy, for what those outside have, is possible. Since most men have exactly a mate, the variety we have will tamp down sexual jealousy for those outside. Envy about possessions is also likely to be rare since sharing makes one rich, and feel richer. Jealousy about others having friends, family and cultural identities is not likely a problem, once numbers go past the first few. Our mutual bonds from the melting and molding of a new awareness will be stronger than the stuck-in-the-same-boat solder humans have had before.

In the outside world we will be subject to rank and class. These would not affect inside behavior. This is less complicated than it sounds; family systems work this way. People do not carry career hierarchies into family life.

Within our groups we will not discuss backgrounds, one way not to trigger or test the adaptive psychological vulnerabilities of adults who have grown up in current societies. Our discussions will be mostly about the symbols and substance of this concept, science, our agenda, and how to make money and convert people in the outside world. That is plenty to talk about. The philosopher, the spiritual, the metaphysic and the atheist we will avoid. Art and literature may still exert its pull and be neutral in effect. We might travel in groups for trips of more than a day, to be sure of being in touch with others we can immediately relate to. Short travel will be solitary.

What happens outside can affect us, since we will spend time there. This would matter more for those who join the transitional society as adults. We might break our precepts now and then in the first few decades. We may be emotionally hurt by others and even by those inside. Sex and money will salve and heal the wounds. The strong and wide mutual bond and the support it implies will provide medium-term support. Seeing more come this way will strengthen long-term resolve.

We will end religion not by fighting the religious, but by changing the conditions which force humans to hold onto faiths. We will follow how the world works to see what new objections to our view come up. But discussing no projection of any future except the one we plan to build. Having no morals, ethics, or shame will help us stop others from exploiting our idealism.

Evolutionary psychology says people form groups based on who they are familiar with, whom they can expect to interact with in the future, and who can be trusted to cooperate. Note that while being driven by these is innate, the cues themselves are modulated by what we know. There is no genetic hardwiring which tells us whom we can expect to continue to see down the road. In the transitional world, guidelines people use to associate with others will favor us being a group. Cues such as who is likely to be around in the future favor this. We will trust our own more than others. Familiarity will strengthen over time, since it is a function of past experience. In sum, based on what science says our nature is like, we will not be forming internal cliques.

Language barriers will exist for the first generation but will be less than in our current worlds. Worries about sounding or seeming bad speaking a broken tongue will not be there. Patience to teach languages will also be more. The second generation, growing up in multiple regions, will learn many languages. Over time a pidgin will emerge. One language from and for all will result.

The transitional world will not be ideal. But over time it will move directed by us to that end. Both because of the first generation gaining experience with managing shared resources, bringing up children with this idea fixed in their minds, and the second generation growing up directly influenced this way at developmental stage itself. At all points our way will preferred to what the outside has to offer, because of resource sharing, satisfying wants in their variety, and a strong support system and bonds.

17.2 Practice

Chapter 11 on page 229 is a blueprint of the society those who believe in it are to build. To get there from here we need to make people aware of this book and its content. We will ignore all discussion in which people are viewed along the lines of race, ethnic, national and similar social divisions. The ideal world is equally distant from every existing culture and social system.

Our females will give us sex free when we need it. Men should support them physically for pregnancy and menstruation-related issues, with childcare and all economic issues a common responsibility. Apart from this women will be free to do what they want to.

There will be many on the sidelines with each differing in ethos and experience. It is impossible to correct for such variation while making a pitch. But true wired wants of all of a gender are the same. We have to emphasize how this ideal society, and no other, accounts for basic needs. To make people aware of those needs, the corrupting influence of current conversations and conventions, the prevailing talk and taboos, needs to be exposed.

There should be no centralizing the way cults do. The practical idea is to live all over in the existing social setup forming a virtual online community. We will live in common childproofed apartments or houses where any of us can walk in and stay. Clothes can be shared since they will be washed after every use. Not owning anything means we can travel light, and stay at a shared house without bringing anything much. Computers, books, items for hygiene, food items, cooking items, bags and wallets, sports equipment, and cleaning equipment will all be owned by all and not moved from house to house. Cars will effectively be common, but the law requires that owners be specified. Cell phones will be public with only the SIM cards being personal. Food items will be stocked at the apartments or houses. Whoever is in at any given time will cook, eat and leave the rest around. At the outset, we will use software to track who is where to ensure houses are not vacated for long. Just updating one's own location would be all that is manually required.

We will maintain joint accounts. Money cannot be made to disappear just by us since the rest would still use it. Joint accounts, however, imply equal sharing—the closest to a money-free world right now. This also gets us financial security and clout from unfettered access to a pool.

A distributed database should be maintained with contact information. Free lifetime email addresses are a must to stay in touch. All languages are to be used with translation back and forth when needed. All should subscribe to a mailing list to discuss and debate issues. A list archived and maintained as a closed, unmoderated newsgroup. We should go for passports which make it the easiest to travel with the lightest litany of laws to obey.

Everyone is to use health-care systems effectively. Vaccines for STD's should be used, imported if necessary. Regular scans are good; the transitional world will require us to follow these rules.

Money is needed in the present economic system, so invest we must. Kids should be brought up to interact with the existing world to the extent they need to make money, and no more. The concept of an ideal society is to be impressed on them as they grow up. They are to be told why to conform to current norms although those are wrong. Kids will be jointly brought up and taught literature, humanities, mathematics, sciences unaffected by the social ethos, those such as physics, chemistry, biology, psychology, medicine and technological sciences, and the descriptive fields of geography and history. They need to be taught good language to wield word as weapon.

We will sell the idea to whoever buys it. Focusing on women who can like and loin-lock all men, minus filters of love and beauty, who can believe beyond the ways and the words and the forms and the hues which reared them. And on men who like their biological pleasures over the faiths they hold to live in a wrong world. As a rejector of roots, one cannot simultaneously keep one of the following beliefs:

1. Laws of physics not always holding, that is faith in miracles or superstitions.
2. Social divisions sanctioned by God, or flowing from inherited dispositions, real or imagined.
3. Controlling biological wants to salvage the soul. This includes fasting and abstinence except for medical reasons.
4. The mating act tailored to give women orgasms.
5. Privacy to mate. Giving this up will clearly prove one no

longer holds any other faith. At least none of the major ones.
6. Children brought up by parents and relatives.
7. Division of labor and competition as preferable.
8. A forced, group, educational system.
9. A dress, cross, beard, thread, bangle, headgear, long hair, or other symbols of any religion. Vegetarianism as a faith, and halal and kosher diets are not acceptable. Those who do not eat beef or pork should have tried it before. We do not want half converts.
10. Proselytizing any religious faith.
11. Free will being the basis of our social and individual problems, and the solution hence being individuals changing.
12. Fate making our worlds what they are.
13. Belief the rooted ones may be partially right on family, social, educational or economic systems. We might have to follow but never accept the commandments or the penal codes. Our way will be flexible but unambiguous.

To follow the law where we must, which means a forced education, for example, may have to be for now. Within the acceptors there will be no class system. The need to convert will primarily drive how we interact outside. Families who accept this vision will split but belong to the same unrooted community supporting and supported from within.

17.2.1 Infant care

We, as a group, will be responsible for rearing our infants. They will not be with parents alone. We will take turns caring for them. Infants may be moved from one region to another where reasonably possible. To ensure care is continuous, all information on it will be entered and stored online. We can depend on daycare only as a last resort.

A toddler will play with everyday items in childproofed residences. Toys will be kept to a minimum. Adults will speak to little ones and teach them how to walk.

17.2.2 Schooling

At school, our children will learn ethics and morals only academically. We will teach them our way. Theirs to celebrate no parties, and attend none. Reading skills will be emphasized along with math and science. Other subjects can be learned equally well later in life.

17.2.3 College

In college, our kids will find their support from within us. They will have no parents, no home but a residence, no relatives, and no best friends. Adoptive parents may be needed for legal purposes. They will mix socially for field work and class discussions, but personal and academic life will be separated. These rootless students will celebrate no milestones, join no group except where it furthers their career, and not take up any role in politics until our numbers are large enough to make our ways more than marginal.

17.2.4 Work for money

Once in the workplace, they will stick to the job avoiding everything else. One can reasonably expect pressure to assume identities, ethnic and otherwise, and attempts to guide or goad one into groups based on those. They will stay equally far from all cliques. Small talk is not required except in some select fields. What is below is for non managerial employees in professions not directly dealing with customers.

The pseudo socialization of the workplace is not for those who disagree with its precepts.We will talk mostly to convince those likely to switch. Our interviews will stick to the job description, both as candidates and as interviewers. Performance reviews and salary negotiations need no special attention except in emphasizing separating work and social life. Vendor and customer interactions should follow the same pattern Careers mean little to us; to many today best summed as the Prozac slipping between the cup and the lip.

Those opposed will try what is legal to stop us. Subtle jabs at this ignorant way, and subtle praise for the family one, will pop up. The religious are likely to try to show how attached they are to their partners, and what we miss in love, romance, adventure and sex from a woman dedicated to one. There will be constant pressure to conform, in conversations difficult to reject without being rude. Our old identities will be raked up, pitied or praised, to yoke us to our moorings, to prison us in our past. The workplace is where we will be forced to mix the most, and there we will be forced to make our stand. Hiding our beliefs will not be an option; they will show through in the environment of our businesses. We will draw sustenance from the protection of the rootless, a unique group spirit, shared wealth, and the variety in satisfying wants we have. We will be proud of our sex norms and the rest of the sharing way. That our way satisfies men's needs better, with constant access to youth and variety, is something we will be sure of.

These tenets cannot be rigid; fields like marketing and managerial jobs require adjusting without getting absorbed. In such cases, one may have to hide one's true identity, specifically to help our agenda. This philosophy bars no career in the transitional world, except the few which directly harm people. Our doctors will not circumcise except where medically needed. Where that is legally disallowed, we will not be pediatricians, obstetricians or urologists.

Seeing large-enough human groups as sharing the same qualities will help us understand how the world of those rooted in their identities moves. That world will be one of the left-behind cultures catching up and passing the dominant one. We will invest our money driven by that belief, and this will help multiply assets. The pull from the momentum of the rising world we will use only to further our own interests. These rooted worlds we will observe, preach to, work and invest in, but never immerse ourselves in. The light of our beliefs shows us the future of that world after the copying is done. The new worlds will steadily incrementally plod on the path of the past

We are pledged to the path beyond the rise and fall of man's divisions, to the creed his memories should begin with, to share and share alike.

17.2.5 Public behavior

We will eat alone, move around alone, and not frequent entertainment centers except as part of work. There will be no public displays of affection, or ostensible camaraderie. That we will help one another would be obvious to the rest.

17.2.6 Our work

Technology we will exploit and invent. Software to track bringing a child up is necessary, to allow distributed care. For an infant, this includes feeding habits, diaper change times, sleeping habits, illnesses with symptoms, duration and treatment, and similar information. For toddlers, in addition, we would record progress in walking and talking. The database will continue through life. All of us will be able to access it. Contact information will be part of it. In most cases, these would be email ids, phone numbers, instant messaging ids, and residential addresses indicating where the person is at presently. For adults who move to the transitional world, the database has to be created new, and will include food preferences, educational background, jobs held, medical history, and any special needs.

Technology will also be used to jointly manage our finances. Individuals who join will make all their accounts shared, but leave the money where it is. Those who want to withdraw money or set up automatic payment systems can use whichever asset base they prefer. We will not skimp on food, drinks, comfortable shared apartments or houses with amenities, medical procedures, technology such as computers or online connectivity, books, and comfortable travel.

We will follow the behavioral sciences—evolutionary psychology, behavioral genetics, neurochemistry, neuroanatomy—and the social sciences of economics, anthropology and sociology closely. Along with the historical aspects of geology and paleontology since these are linked to our origins and new details here could be used by others to object to this idea. While the book supports the view with a general argument not tied to the current state of these fields, fitting newer details into the schematic structure will be useful to persuade others.

We will spend time on research, technology to better our lives, and debates and discussions.

Every acceptor agrees to:

- Protect our own with everything but life and limb. The first few will need it at every turn.
- Share, including hetero sex partners.
- Cut all ties to existing social systems including spouses, parents, relatives and where legally allowed, children.
- Not socialize or entertain except for work or to convert people.
- Always identify as one of us except when we decide to hide to push our agenda. That way avoiding most talk.

A A primer on genetics

A.1 Chromosomes and genes

Our bodies are made of cells. Each cell has a nucleus, which contains information on how to duplicate the cell, and how to control its functioning. This information is packed into a molecule called DNA, made of 46 units called chromosomes. Of these, 44 chromosomes exist in pairs called homologues, that is 22 pairs of 2 each. The remaining two are the X and Y. Every chromosome has some important sections called genes.

The basic unit of a chromosome is called a nucleotide, and can be one of 4 molecules: A (Adenine), T (Thymine), G (Guanine) and C (Cytosine). The DNA molecule is a long strand of these nucleotides, organized into the 46 chromosomes. The strand exists as a pair twisted into a double helix. The DNA paired strands are not independent; the first uniquely determines the second, with A pairing with T and G with C. Thus if a strand has the sequence A, T, T, C, A, the second would have T, A, A, G, T. We can ignore the second strand for most descriptions.

A gene is a nucleotide sequence, typically many thousands long, which makes a specific protein. The sequence of a gene might be slightly different in different individuals, and each version is called an allele. Every pair of chromosomes has the same set of genes, that is the same set of regions which code for the same set of proteins. However the versions or alleles of the gene in the two pairs may differ. The allele combination in the two pairs for a given gene is called its genotype. If the versions are the same, the genotype is homozygous and if different, heterozygous. When two different versions of the gene exist in the pair, one may override the other and is called the dominant version, with the other the recessive one. If both interact, then they are codominant. The entire sequence of genes making up an individual's DNA is called the genome.

A man has the 22 paired chromosomes, an X chromosome and a Y chromosome. The Y chromosome contains the sex-determining region, a gene portion which causes people to be male by indirectly coding for more testosterone. A woman has the 22 paired chromosomes, and two X chromosomes, of which only one is active in any given cell.

When a gamete, that is an egg or sperm cell, is formed, it has only 23 chromosomes. The 22 pairs plus either an X or a Y. During fertilization, in the fallopian tubes leading from the ovaries to the uterus, the sperm and egg DNA fuse recreating the 46 chromosomes. If the sperm carried an X, the result is a girl baby, and if it carried a Y, a boy. The resulting fertilized cell then divides, creating a blastocyte. The blastocyte travels and embeds itself in the lining of the uterus, endometrium, and grows into an embryo, with a placenta around it.

So, of the genes in our 22 pairs, one comes from the father and one from the mother. In a man, the X chromosome always comes from the mother and the Y from the father. In a woman, the one active X chromosome could be the father's or the mother's. Different cells choose different X chromosomes randomly.

A.2 Cells

An animal cell is mostly cytoplasm enclosed inside a cell membrane. The cytoplasm contains a nucleus, a mitochondria, an endoplasmic reticulum with or without ribosomes, and a few other structures. The nucleus contains the DNA molecule, plus some proteins. The mitochondria produces energy by combining carbohydrates with oxygen. Mitochondria also contains a small DNA sequence, which creates the proteins required for this process. Mitochondrial DNA works alongside nuclear DNA. Ribosomes are workbenches for making proteins. When a cell is not dividing, active in interphase, the DNA is uncoiled inside the nucleus.

External input into the cell comes via the cell membrane. These cause chemical changes inside the cell, and may cause some genes to turn off and some to turn on. The proteins produced by the genes may also cause other genes to turn off and on. What exactly a cell does, that is whether it ends up as a part of a pump, the heart, or whether it ends up as a nerve cell which can signal chemically, depends on which genes in its nuclear DNA are active.

A.2.1 The cell cycle

Cells divide almost every 16 hours. A cell alternates between the dividing and non dividing stage. The division process is called mitosis. The non-dividing stage is the interphase stage. During interphase the nuclear DNA exists in uncoiled state. Protein synthesis from genes takes place during this time. A molecule called mRNA binds to DNA, and makes a copy of the DNA and carries it outside the nucleus to the ribosome. Inside the ribosome are tRNA molecules which specify how the DNA information is to be translated into proteins. The mRNA, tRNA and another version called the rRNA combined create proteins.

Cell division involves splitting the two strands of DNA apart and synthesizing two new complementary strands. At the end two nuclei reform enclosing each DNA duplex strand, and the cytoplasm divides to form two new cells. On every division, a certain sequence at the end of genes gets shortened on one strand. This sequence comes after the end of the gene, and is called a telomere. In humans, the telomere sequence is TTAGGG . . . repeated many times. In certain cells, such as gametes, fertilized egg cells, early embryo cells called germ cells, and blood cells, an enzyme called telomerase lengthens the telomere again after each division.

Cells divide another way to make gametes—sperm and egg cells. These cells have only one copy of the chromosome, not pairs. These are hence haploid cells as opposed to the normal diploid cells. They are formed by meiosis, which splits a single cell into 4 gametes. In women, all eggs are formed before birth, and are arrested in a specific stage of meiosis. When ovulation starts, they go further in the stage, but stop again. The final division takes place only after the egg is fertilized by a sperm cell. In men, sperm cells are generated continuously throughout life. The cell line that finally undergoes meiosis to produce gametes is called the germ line, and the other cells form the somatic line.

In meiosis, the two chromosome pairs are not always cleanly split and put into different gametes. Sometimes the chromosome pairs exchange genes, via recombination, also called crossing over. In women, this happens before birth, since egg cells are arrested in meiosis after the recombination stage. Because of recombination, the chromosome pairs we carry are not exactly one from the mother and one from the father paired together. Genes get shuffled between the two chromosomes of the father's original pair. We inherit a mosaic chromosome from each parent. If, in a pair, the first had the gene sequence G1, G2, G3 and the second H1, H2, H3 (with G and H being different alleles of the genes), the sperm or egg might end up with G1, H2, and G3 or H1, H2, and G3.

What about chromosomes which are not true pairs—the X and Y? A small section of the Y can recombine with the X, but most of it is passed intact from father to son. The cytoplasm of the fertilized egg, and hence the zygote, is derived from the mother. Hence mitochondrial DNA is passed from the mother to all children. It can be used to track maternal lineage.

A.3 Mutations

Mutations happen typically during DNA replication when a cell divides or forms gametes. Generally, there are two types: chromosomal mutations and gene mutations.

A.3.1 Chromosomal mutations

During meiosis, a gamete may end up with a chromosome absent, or 3 or more pairs of it present. The first condition is called monosomy. A 3-paired chromosome is a trisomy. In humans, these conditions mostly lead to nonviable fetuses (that is fetuses which do not live till birth). About 15 to 20% of all human conceptions are terminated by spontaneous abortion, and of these about 30% are chromosomally abnormal. Polyploidy is the case where the entire genome is duplicated multiple times, and is mostly seen in plants but rarely in mammals.

A.3.1.1 Monosomy

In humans, monosomy is seen only for the X chromosome, in females, leading to a disease called Turner syndrome, in which a woman has 45 chromosomes, missing one X. This is referred to as the (45, X) karyotype. The rate is around 1 in 2500 to 5000 births. Women with this are mostly normal but at higher risk for medical complications and ovarian cancer.

A.3.1.2 Trisomy

Trisomy of autosomal, non X/Y, chromosomes is rare in living humans, and all cases are medically abnormal. Trisomy of chromosome 21, trisomy 21 with karyotype (47, +21), leads to Down syndrome. This is seen more in children of older women, with ageing of the egg seemingly causing it to degrade. Trisomy 13 is Patau syndrome, and trisomy 18 Edwards syndrome. These babies do not go past the first year. Trisomy of the X,Y pair is more common. The (47, XXY) karyotype results in Klinefelter syndrome, and (47, XYY) in taller men with some ill-defined learning disabilities. Whether this is a medical condition is debatable. Klinefelter syndrome men are infertile, and slightly more feminine looking, but largely normal.

A.3.1.3 Deletions

A deletion, or deficiency, is a missing piece in a chromosome. If the deletion is at an end of the chromosome, it is called a terminal deletion, and otherwise an intercalary deletion. This can remove one gene pair in a chromosome, causing a recessive allele to pseudodominate.

A.3.1.4 Duplication

A duplication is where the generic material is duplicated along a chromosome. It can happen due to replication error or incorrect crossing over. Gene duplication leads to new genes originating. In effect, the inessential duplicated gene can accumulate changes in the germ line in a neutral way, and eventually become so different as to qualitatively change the phenotype.

A.3.1.5 Other structural changes

Inversion is an aberration where a segment is turned around within the chromosome. It rearranges the linear gene sequence. Translocation moves a chromosomal segment to a new location in the genome. This could be reciprocal between two chromosomes or not. Chromosomes can also break at specific fragile sites where the bonding is weaker.

A.3.2 Gene mutations

Gene mutations can be point or frame transition mutations. A point mutation changes a single nucleotide. A frame transition mutation is one where a nucleotide is either deleted or inserted.

A.3.2.1 Point mutations

Nucleotides are arranged in groups of three, forming a word. Each group of 3, called a codon, codes for a different peptide (a component molecule of a protein, consisting of carbon, hydrogen, oxygen, nitrogen, and sulfur in various combinations). These words are arranged into paragraphs called exons. A gene also has fillers in between exons called introns, and the nucleotides there are inactive. At the beginning of every gene is a specific sequence which identifies the start, called the start codon. At the end is a special sequence called the stop codon. Before the start of the gene is a coding region called the promoter which determines how often the gene activates and produces proteins.

Point mutations change a nucleotide into another. These mostly happen while cells divide, since the double strand is then split. When a new strand is synthesized, a base pairing difference can lead to a nucleotide changing. A point mutation changes one peptide in the polypeptide (many peptide) chain which makes up a protein.

One mechanism which causes a point mutation is a tautomeric shift of the nucleotide. A tautomeric shift changes a nucleotide to another form, a tautomeric form, differing by only a single proton. This can cause the pairing affinity to change, causing T to align with G and C with A. When DNA is replicated, this will cause a T, A pair in the duplex strand to be replicated as a C, A pair by the anomalous pairing, which on the next replication would change to a C, G pair on one copy.

Why not an anomalous A, G pairing or T, C pairing? Nucleotides A and G are purines, with two carbon-anchored rings, and C, T pyrimidines, with a single carbon-based ring. This means A and G are bigger than C and T, and base pairing always happens between a smaller nucleotide and a bigger nucleotide (a purine and a pyrimidine) even with tautomeric shifts. A purine-purine pairing will result in a long pair, and a pyrimidine-pyrimidine pair will be short. For DNA structure to stay a helix, the length of every base pair has to be the same.

Point mutations can also be caused by mutagenic chemicals which act as base analogs replacing a nucleotide, but pairing anomalously. A derivative of uracil, 5-bromouracil, can replace T, but pair with G in addition to A. Another base analog, 2-amino purine, can replace A, but pair with C in addition to T. Nitrous acid can cause point mutations in C and A, by deaminating them to uracil and hypoxanthine.

A.3.2.2 Frame shift mutations

When one or two nucleotides are added or removed, all codons which follow are affected since the frame of reading changes. When the number of nucleotides changing is not a multiple of 3, we get a frame shift mutation. These can happen when strands slip during splitting. Many chemicals, alkylating agents such as mustard gases and acridine dyes, can cause frame shift mutations. Sometimes an A or a G can disappear from a DNA molecule by the breaking of the bond linking it to the backbone structure of DNA (the deoxyribose sugar). Ultraviolet radiation can cause frame shifts. So can X, gamma and cosmic rays.

There are genetic units called transposons which can move from one place to another or even to another chromosome on their own during DNA replication. Such insertion sequences are more likely to jump to certain target sites than others. These can cause frame shifts by jumping to a location inside a gene.

A.3.2.3 Repair mechanisms

Not all mutations are carried across after replication. Some are rolled back via different mechanisms. The enzyme which polices the synthesis, DNA polymerase, can proofread the result, and correct incorrectly paired nucleotides. After rollback, about 1 in 10 million mismatches occur following DNA replication. The rollback rate is increased a thousandfold (at least in bacteria) by the next round of checks, called mismatch repair.

A.3.3 Mutation rates

Mutation rates vary between species. Viral and bacterial genes mutate on average about 1 in 100 million cell divisions. In humans, and oddly maize and the fruitfly *Drosophilia Melanogaster*, the rate is around 1 in 1 million per gamete formed. Mouse genes mutate around 10 to 100 times faster. The total mutation rate in humans is about 4.2 per person per generation. About 1.6 of these are eliminated by reproductive selection, but this last number is thought an underestimate, with one estimate being about 3 mutations eliminated per person. Not all genes undergo mutation at the same rate, with some being more prone to changes than others.

A.4 The Hardy Weinberg equilibrium

If a gene exists in two alleles, say A and a, with ratios p and q in the overall population, then the ratio of the genotypes AA: Aa: aa = $p^2 : 2 \times p \times q : q^2$. This is under conditions of random mating, for a large population, with no immigration, emigration, mutation and selection.

The derivation is easy. With random mating, the probability of AA is the probability of the father having an A, multiplied by the mother having an A, which is $p \times p$. The other ratios are derived similarly. Note that, in the next ratio, the allele frequencies are, for A, $2 \times p^2 + 2 \times p \times q$ which is $2 \times p \times (p + q)$, that is $2p$, since $p + q$ is 1. Similarly for allele a, it is $2q$ and so the ratio is in equilibrium at $p : q$.

A.5 Genetic drift

The Hardy Weinberg equilibrium is fundamentally unstable since it is probabilistic. Note that all of the population having the same allele, either A or a, is a deterministic equilibrium. Once a population lands there, it stays there for good, within the conditions noted earlier.

If in the space of all possible combinations, a deterministic equilibrium exists, and if there is a non-zero probability of getting to one of those combinations on the next step, then eventually the population will end up in a deterministic equilibrium. Deterministic equilibriums trump probabilistic ones.

This is similar to walking around a room with a trap in it. Assume there is a small, but non-zero, chance of falling into the trap p. If we keep walking around at random, after the first round we are likely to avoid the trap: the chance is $1 - p$, say q. After the second round, the chance drops to $q \times q$. It drops since $q < 1$. After every successive round, the chance drops toward 0. That means, given enough time, we will land in the trap.

The condition there be a non-zero probability of landing in a deterministic equilibrium (a trap) on the very next round is not a must. It is enough that there be a non-zero probability of getting there in a finite number of steps. Allele trapping works that way. Given enough time, genes get fixed to just one allele by genetic drift. The allele would also end up homozygous.

A.6 Interaction of mutation and selection

One of the more interesting parts of evolution theory is that selection is expected to work against mutation. If a gene which can stop mutation arises, say by improving meiosis fidelity, that gene will be selected for, since it improves every gene's replicative fitness. This means the sieve of natural selection will act to genetically improve gene replication fidelity. Natural selection will try to tamp down mutations by using repair mechanisms. Mutation rates should hence be low in species.

A.7 Neuroanatomy

The human nervous system is divided into the central and peripheral systems. The central system is the spinal cord nerves and the brain. The peripheral system is all the nerves which lie outside the cord and the brain.[84]

There is also the sensory division, which carries senses to the spinal cord or brain, also called the afferent system. The motor division which carries signals to the muscles, is also called the efferent system.

Functionally, the nervous system is made up of the somatic system, responsible for everything under conscious control, and the visceral or autonomic nervous system which coordinates involuntary functions such as breathing and digestion. The autonomic nervous system is divided into the sympathetic division and the parasympathetic division. The first prepares the body for expenditure of energy, such as dilating the airways into the lungs, raising hearbeat, and stimulating ejaculation. It is called the "fight or flight" subsystem. The second helps bring the body back to normal, by restricting the airways, lowering heartbeat, and stimulating sexual erection. It is the "rest and digest" system, though with respect to sex, the term is misleading.

The spinal nerves are divided into sections, from the head to the waist. There are 8 cervical segments (C1 to C8), 12 throacic (T1 through T12), 5 lumbar (L1-L5), 5 sacral (S1-S5) and 1 coccygeal (Coc1). The nerves exit the enclosing vertebra through the openings called the foramina. The spinal cord enters the skull through an opening called the foramen magnum. The position and orientation of the foramen magnum of an animal can tell us whether it walks upright or on all fours, since the angle between the cord and the skull has to be different for the two cases.

The brain is made of two types of calls—nerve cells called neurons and glue cells called glia. Neurons can signal one another electrochemically. They are interconnected through the branches of a tail called an axon. The branches are called dendrites, and where the dendrites from neurons meet, we have synapses. Most neurons signal by releasing a chemical, a neurotransmitter, which is a hormone. There specific sites on the neuron, called receptors, which allow in neurotransmitters released by its connected neurons. Each neurotransmitter has a specific kind of receptor, or multiple receptors.

A.7.1 Sensory perception

A.7.1.1 Vision

A.7.1.2 Audition

A.7.1.3 Somatic sension: touch, pressure and pain

In hairless, glabrous skin, four types of mechanosensory receptors are found. These are Merkel cells, Meissner corpuscles, Ruffini corpuscles and Pacinian corpuscles. The axons associated with them are all of type A-beta, which conducts at about 42-72m/sec. On another level, the axons can be classified as slowly adapting (SAI, SAII) or rapidly adapting (RA). On a prolonged stimulus such as continued pressure, the first type continues to fire, while the second produces a burst and then stops (adapts). Hairy skin has an additional receptor, the D-hair receptor or HFA (hair follicle afferent).

Proprioception is the awareness of the position of the body and limbs. For this, we have muscle and tendon receptors, along with joint afferents which detect when a joint is over-flexed. The muscle spindles are arranged alongside the muscle fibers, and detect how much a muscle stretches or contracts.

Nociceptors detect noxious stimuli, hence the name. Mostly this includes pain, heat and chemical irritants. They also generate the axon reflex. Explain here.

The ascending pathway: VPL, VPM, SI, SII. area 3b. ventral path to temporal lobe... dorsal path to SPL for control of voluntary movements.

Spinal cord arrangement, Dorsal column nuclei, Lateral Cervical Nucleus, Medial Leminiscal, PAG, VPL, POm,

Nociception: laminae I and IV/V, anterior spinothalamic tract, VPL/VPI, intralaminar nucleus, central lateral nucleus. Mediodorsal nucleus. PoM. empathetic pain. Imagined pain. Placebo effect.

Other paths: PAG referred path, allodynia, secondary hyperalgesia, phantom limb

Trigeminal:

Lateral inhibition in S1. Columnar organization. hierarchy. body representations. attention modulation.

A.7.1.4 Olfaction

A.7.1.5 Gustation

A.7.2 The motor system

A.7.3 Attention and its control

A.7.4 Memory

A.7.4.1 Declarative memory

A.7.4.2 Non declarative memory

A.7.4.3 Working memory

A.7.5 Emotions

A.8 Criticism

To parse correctly the various papers highlighted by the media, one needs to know the limitations of the various fields, and one way is to look at the criticism they have attracted.

A.8.1 Evolutionary Psychology

The field has come under heavy and constant criticism from anthropologists, biologists, evolutionists and other psychologists.

The first criticism against this science, voiced by Paul Ehrlich and others is its hyper adaptationism.[85] Psychology has long considered the brain a general-purpose learning mechanism, conditioned by learning to solve problems. This view is against the fundamental tenets of EP, which views the brain as a collection of behavioral modules, adaptations. The theory does not conclusively prove a general purpose learning mechanism failed to evolve under the selection pressures of the past. While some evolutionists claim there is no such thing as a general learning mechanism, since a computer works only running a software program which is special purpose, this view is computationally incorrect. Learning algorithms do exist which are general purpose, especially in the field of AI (Artificial Intelligence). The simplest is a classifier which can classify any input into classes, say 0 or 1. The algorithm has to be trained with a set of examples whose answers are known, but once trained it works mostly correctly on arbitrary input. Its working is domain independent. The workings are related to probability theory, attempting to fit an algorithm which minimizes the probability of error for the set of training input with known output. Artificial Intelligence has succeeded in solving some problems with this approach, avoiding problem-specific solutions. Why natural selection would not have preferred the rise of such mechanisms at the expense of modules designed to solve specific problems is unclear. The central question is whether the general learning scheme is superior to a set of solutions tailored to, and optimized for, specific problems, in terms of overall costs and benefits. Evolutionary psychologists have bet it is not. There is nothing in computation theory to back the bet.

The second criticism is they rely on studies of the adult brain to detect hardwired traits. This ignores cultural effects, and learned memory. Evolutionists respond to this claiming our societies fundamentally flow from our biological propensities, and hence their influence can be ignored. This however introduces a second critical assumption, that humans have in the recent past followed their adaptation mechanisms, and not used the conscious overrides much. The conscious overrides we possess are themselves adaptations, but largely outside the purview of EP. If it turns out our societies are more the product of our conscious overrides and free will rather than the basic adaptation mechanisms, then their influence cannot be ignored.

To address this, in some cases, scientists justify the procedure by showing the brain regions are known to be subconscious ones. In others, they try cross-cultural studies. Unfortunately, brain scans, almost by definition, are done only in societies with scanners. Social mixing ensures many aspects of culture become common across societies not because they are biologically innate, but because cultures interact. Any society with a functioning MRI scanner has imbibed many aspects of Western culture already.

In other cases, such as the female orgasm, some evolutionists have plainly ignored non-Western cultures. Gould, Symons and Lloyd, the first two being pioneers in the field, pointed this out. Those who claim orgasm is an adaptation tend to see cultural influences impeding it in other societies. But the equally valid hypothesis, cultural influence facilitating it in this society, is ignored. Especially when the historical record is against its species generality.

The third criticism is the looseness of the general theory. Human behavior spans the range from parental sacrifice to infanticide. Explaining contradictory behavior with a general theory leaves the public confused. Reverse engineering and then explaining a behavior is fine. But how does one use the theory to predict, if it can accommodate mutually contradictory results? While evolutionary psychologists come up with differing developmental tuning, and different input to the various interacting adaptation mechanisms, as the reason, this still leaves the original problem intact. One feels the science explains behavioral variety by underspecifying the result.

The fourth criticism is its predictions often follow what people already know about societies. That men are more violent, for example. Building a theory of violence, then predicting males would be more violent as per the theory, conducting a survey or brain scan to prove this, and considering the fulfillment of the prediction as validating the theory, fails to impress. Trivial predictions abound in EP literature (examples—parental investment prediction: men want short-term sex while women want long-term commitment, men look for physical attractiveness in short-term mates; kinship selection prediction: step parents are less friendly to kids than genetic parents, everybody helps relatives more than strangers).

The fifth criticism is evolutionary psychologists are often biased by the cultural milieu they are supposed to investigate. They tend to overlook the selective bias of their hypotheses and predictions, introduced by their upbringing. Buss, explaining the base rate fallacy: "Imagine there is a roomful of people, 70 percent of whom are lawyers and 30 percent of whom are engineers. One is a man named George who dislikes novels, likes to do carpentry on weekends, and wears a pocket protecter (sic) in his shirt pocket to carry his pens. His own writing is dull and rather mechanical, and he has a great need for order and neatness. What is the probability that George is (A) a lawyer, or (B) an engineer. Most people tend to ignore the base-rate information, which suggests that it is more likely that George is a lawyer (70 percent of the people in the room are lawyers). Instead, they give too much weight to the individual information, which is highly salient, and declare that George is likely to be an engineer."

The sixth criticism is the heavy reliance on natural selection. Some evolutionists such as Gould believe blind chance and luck have contributed more to some organisms surviving at the expense of others. This would lead to a radically different look at how the sieve of natural selection operates. It does not always maximize reproductive fitness; climatic changes and geological events could lead to groups surviving from sheer luck, being at the right place at the right time.

None of these objections are meant to detract from the only science that tries to describe our psychological nature. They are intended to show the nascent nature of the field, and the care one should apply in evaluating what gets reported in the popular press. Science works by accumulating evidence. Just one or two pieces of evidence often suffer from the objections listed above; it is when we have many pieces to support a theory we consider the issue settled. Most of what I have covered is truly not settled in this sense. But I assume they are likely true to show in detail why an ideal world is not precluded by the findings of this latest science.

B Notes

1. The utopias cited are based on dividing labor (Plato, [67]), based on economics (Marx, [61]), a good God (Genesis, the Bible), efficiency (Rand, [71], [70]), technology (Asimov, [5]), social justice (Raskin, [29]), and primitivism (Kaczynski, [45]).
2. The exact math is complex (Hamilton, [37]).
3. R. A. Fisher was an evolutionary biologist, not a psychologist. His work synthesized Darwin's amorphous theory of natural selection with the idea traits are genetically transmitted. His work is mathematical, focusing on population genetics. W. D. Hamilton introduced the second most important idea underlying EP —kinship selection, also called inclusive fitness. His two papers founded the math behind the theory. Others would empirically verify it over the years. George C. Williams published *Adaptation and Natural Selection*, defining an adaptation, overthrowing the idea of group selection, and exploring inclusive fitness in detail. John Maynard Smith introduced the idea of applying game theory and strategies to studying natural selection in *Evolution and the Theory of Games*. Specifically he adapted the Nash equilibrium concept from economics to generate theories on ESS (Evolutionarily Stable Strategies). Robert Trivers published three major papers in the 70s introducing the idea of reciprocal altruism, parental investment theory, and parent offspring conflict. Richard Dawkins published the popular *The Selfish Gene*, looking at natural selection as selecting genes, and not organisms or species. Despite being meant for the public, its rigor ensured academics would treat it almost as a standard text. Donald Symons looked specifically at the evolution of sexuality in the *The Evolution of Human Sexuality*. Buss calls Symons the author of the most important treatise on the evolution of human sexuality in the twentieth century ([15], acknowledgments). Martin Daly and Margo Wilson would publish papers on jealousy and violence, and publish a book jointly: *Sex, Evolution and Behavior*. Leda Cosmides and John Tooby, a couple, would look at evolutionary mechanisms controlling social behavior and exchange among humans, going beyond kinship selection and reciprocal altruism. David Buss published a textbook, *Evolutionary Psychology: The New Science of the Mind*, summarizing the state of the field. The *Handbook of evolutionary psychology* is a recent work, and covers the topics of interest to us in depth.
4. [87], Chapter 2.
5. [14], p. 43.
6. [14], p. 108; [16], p. 268.
7. [82].
8. [48], [90] and the references they cite.
9. [81], [14], p. 59.
10. [89].
11. [89].
12. [89].
13. Except where noted, the material is from [22], a detailed and oft-cited book on sex behavior in the animal world.
14. [20].
15. [21].
16. [83].

17. [8], p. 173-178.
18. [8].
19. [80].
20. [8], p. 83.
21. [8], p. 80.
22. ([8], p. 132.
23. [8], p. 132.
24. [8], p. 80.
25. [8], p. 71.
26. [8],p.129.
27. [8], p. 92.
28. [8], p. 130.
29. [57].
30. [8], p. 96.
31. [8], p. 246.
32. Alfred Kinsey and others, *Sexual behavior in the human female*, ([49]p. 580, yes, it is that big a book.
33. *New Sex Therapy* ([47], p. 28.
34. [84], p. 71.
35. Quoted on p. 126 of [84].
36. [47]
37. [40], p. 205.
38. [30].
39. [56], p. 39.
40. [40], p. 345.
41. [39].
42. [34], p. 444.
43. [81], p. 291.
44. [15], p. 82.
45. [16], p. 269
46. [17], p. 269.
47. The synopsis here is from [79], pages 803 and 927.
48. [16], p. 381.
49. [34], p. 445.
50. UCBerkeley professor Kirstin Scott's description in [79], p. 577.
51. [81], p.92.
52. [46], p. 153.
53. [46], p.145.
54. [81].
55. [88].
56. This is the model in [79].
57. Here again we follow [79].
58. [16], p. 420.
59. [16], p. 424.
60. ([66]).
61. Bullough, [13], p. 25). Bullough's is a biased account, with the opening chapter on "Cul-

ture and Sexuality" mostly describing homosexuality, as if that should be considered the norm

62. ([13], p. 494.
63. ([18], p. 797.
64. [18], p. 797.
65. [74].
66. In [79], with one editor from the same institute as Levay, the finding is not mentioned.
67. [11].
68. [36], [33], [9].
69. ([2].
70. [28].
71. [51], p. 83.
72. [16], p. 689.
73. See [89], Chapter 12, for an example.
74. [15], p. 68.
75. [14], p. 287.
76. [25] p. 157.
77. [86].
78. [88].
79. [15], p 188.
80. [15], p 190.
81. [15], p. 80.
82. [79], p. 609.
83. [24].
84. [27].
85. [25].

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