CHAPTER 3

Emotions, Temperament, and Social Homeostasis

From: The Intelligible Self
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What are you feeling right now?

If you're like most people, it's probably nothing in particular. Most of the time, when we simply observe ourselves, we don't identify any distinct emotions or feelings. We may be vaguely tired or hungry or whatnot, but the motivational states that we typically describe as emotions, like joy, sadness, or anger, are relatively infrequent and episodic. Instead, most of us usually feel, well … a normal type of stolid consistency.

This static self-concept is an illusion. Humans, like all animals, are beings of continual movement and our bodies are constantly awash in motivational signals. At a most basic level, the brain stem is constantly adjusting blood, oxygen, and energy flows by altering our breathing and heart rates. Neural and hormonal signals are continually prompting our bodies to do everything from blinking to generating antibodies. Then there is the perpetual activity of our hundred billion some odd neurons. At this very moment, *hundreds of millions* of your neurons are being activated not just by processing the visual information of these words but in an ever-oscillating pattern of electro-chemical activity to reset their action potentials. Our senses are continually receptive to new sights, sounds, and other stimuli that may bring harm or sustenance. Even when we sleep or daydream, our neural system is alive with all kinds of specific information signals and emotional states--the resting brain is anything but.[1] Yet, most of the time, we are largely unaware of the vast amount of activity that underlies our very being. Instead, we tend to perceive ourselves as a singular and unchanging whole.

In our quest to understand ourselves, we need overcome this misconception about a static neurophysiology. We need, in short, to find a way to make ourselves intelligible. Luckily, this is where evolutionary biology actually can provide us with some key insights. The specific neural mechanisms that directed our animal ancestors to eat, mate, flee, rest, and so on, form the basis of our later, more complex psychology, what I called, in Chapter 1, our "primordial ideology." If we want to understand what is going on inside our heads, we need to first appreciate what exactly these animal brains evolved to do.

The next two chapters look at this in more detail. This chapter focuses on neural and hormonal processes that prompt us to act in particular ways: our motivational system. These systems not only provoke our actions but they also make thinking possible. In other words, how we think is fundamental dependent on how we "feel." The rest of this chapter then describes how these motivational systems function. Emotions entail far more than we're usually aware of. Rather than being encapsulated states with names like happy, sad, or angry, our motivational systems are comprised of a much broader constellation of neural mechanisms, most of which operate below our conscious awareness. Some emotions consist of many neural mechanisms, some have only a few; some emotions have traditional names (e.g., happy, sad, angry), but most do not. Each of these motivational elements has a "set point," a homeostatic balance that our bodies seek to maintain and the accumulation of these set points is our temperament. A social species like ours also has a process of social homeostasis, a means of maintaining a temperament for the entire group. Indeed, the purpose of many cultural institutions and practices is to enforce and sustain this social homeostasis. But before wading into this very deep psychological sea, let us start by examining what exactly our brains actually do.

Thinking and Feeling

There are few concepts in western culture that are so important yet more widely misunderstood than cognition and emotion. Most of us tend to view thinking and feeling as largely separate and conscious processes. Thinking is the type of deliberate reflection such as when we calculate the square root of 234 or decide on where to take a vacation. Because we are the only animals who calculate square roots or choose vacation spots, we usually assume that we are the only animals who think. We also have similarly particular ideas about our emotions. If we think of emotions at all, we tend to think of them as episodic states that come with discrete labels like "happy," "sad," or "angry." Just as it is common to assume that we're the only animals who think, it is also common to assume that we're the only animals who feel certain emotions or any emotions at all. Most importantly, we tend to believe that thinking and feeling are separate and distinct mental processes. Although emotions may sometimes "cloud our judgment," our reasoning brain can usually exist free of sentimental influences, or so we'd like to believe.

Unfortunately, these notions are mostly incorrect and the fault lies partly with our intellectual forebears. Classical philosophers like Plato viewed emotions as those troubling expressions of our animalistic nature. Reason was the sole domain, and defining factor, of our humanity. This dualism between animalistic emotion and human reason persisted in western thought: in the Christian tradition, human nature was bifurcated between our sinful, emotional animalistic side and our rational, angelic side; during the Enlightenment, philosophical titans like Descartes, Spinoza, and Kant continued to portray thinking and feeling as separate processes.[2] When they thought about emotions, which wasn't very often, such philosophers tended to dismiss them as a form of base animalism. Reason was what defined the *human* mind, indicating our divine provenance and our elevation above other creatures.

Yet, for all their prescience about emotions as a form of "animal judgment," these classical thinkers knew little about brain function. Over the past decades, neuroscientists and psychologists have torn down the pillars of human psychological exceptionalism.

Today, few psychologists and neuroscientists would describe cognition or emotion as distinctly human traits or believe them as separable from each other. Indeed, many psychologists doubt whether emotions even exist as discrete, encapsulated phenomena. While we need not concern ourselves with the details of this research just yet, we should be clear about how the brain works. So before going any further let's try to shed a little of our cultural baggage and re-conceptualize what "thinking" and "feeling" actually entail.

The best place to start is by reexamining what the brain does.

As we saw in Chapter 1, brains, sense organs, and nervous systems contain many different types of cells that perform a wide range of functions. If we wanted to describe all of what an animal's neural system does, we could come up with an incredibly long list of thousands of specific tasks ranging from the translation of ocular action potentials (i.e. seeing) to the stimulation of adrenal glands (i.e. getting excited). But such a specified list would be too long and unwieldy to be of much practical use.

Instead, we can categorize neural systems by the primary tasks that all mobile creatures face: sensing the world and responding to it. As I noted in Chapter 1, the first animals evolved neurons not simply to collect information about their world but to help them move efficiently within it. It didn't do our flatworm ancestor much good just to sense food, it also needed to be motivated to move toward that source and eat as well. Thus, for expedience, let us group neural functions into two very broad categories of sensing the world and responding to it, with the tacit understanding that these sets are not mutually exclusive and overly generalized.

The first category is what I call *information systems*, which includes all *neural mechanisms dedicated to processing neural data*.[3] They include:

- registering information from the environment and body, (i.e., sensation);
- organizing sensory information (i.e., perception);

- storing and retrieving this information (i.e., memory);
- coordinating physical behavior (i.e., orientation);
- ordering different mental elements (i.e., reasoning);
- generating a specific focus of attention (i.e. consciousness).

Although information systems include those processes we commonly call "thinking," most are not about generating particular thoughts and actually occurs well below our consciousness.[4] We're not really aware of how our eyes see, why sugar tastes sweet, how we remember that our car is parked behind the bank, or how we know up is up. Such types of thinking just seem to happen. "Thinking," in other words, involves a lot more than what we are usually aware of. Most importantly for our purposes, these information systems can be found in any animal with a nervous system.

The second category is the *motivational system*, and includes what most people call emotions (or what psychologists often refer to as "affect"). Psychologists and philosophers have long debated how to describe emotions and numerous definitions abound.[5] Rather than try to adjudicate these various conceptions here, I offer instead a simple, and hopefully useful, definition: *motivational systems are psychological processes that prompt behavior*. By this definition, this motivational system encompasses a wide range of psychological processes including:

- reflexes;
- circulatory regulation (e.g., heart rate and breathing);
- evaluative sensation (e.g., pain or pleasure);
- instinctual drives (e.g., hunger, sexual arousal);
- dispositions and moods (e.g., depression or mania);
- "traditional" emotion states (e.g., anger, fear, joy, surprise, disgust, love, and sadness).

At first glance, it may seem strange to group reflexes, pain, or desire in the same category with traditional emotions like anger or sadness. But reflexes, pain, desire, and even anger all work towards the same general purpose--to motivate animals to act in particular ways. A reflex makes us instantly pull our hand from a hot stove, a sharp pain makes us stop walking on an injured leg, desire moves us to procreate, anger motivates us to fight a dangerous adversary, etc. It also makes sense to group these motivational processes together because they are highly integrated with each other. Emotions like sadness, anger, and surprise make us "feel" particular ways and these feelings arise from our neural systems involved in reflexes, pain, or pleasure. When we "jump in fear" or "melt in love," it is our reflexes that are motivating the jumping and melting; the "heavy heart" of sadness and the "lightness of ecstasy" arise from neurological systems of pain and pleasure.[6] Rather than only think of emotion as those state of which we have conscious awareness or particular words to describe, it is more accurate to place emotions within *all* those mental processes that evolved to direct animal behavior.

But in its primitive neural system, there simply wasn't the capacity for making deliberate, reasoned evaluations. So instead, it relied on automated response mechanisms, basically akin to reflexes, to move toward a particular stimulus. A flatworm has neural receptors that bind to chemical signatures from food sources and the information from these cells triggers a simple neural process that directs the other cells to move the flatworm toward the food. This is how a flatworm "thinks" and "feels."

These same primitive neural processes comprise the foundations of our complicated, mental lives. As animals evolved more sophisticated sense organs, their cognitive systems also evolved ways to systematically organize this information. When animals developed coherent "brains," they also developed a greater capacity for perception and orientation—flatworms began to differentiate between sensations and move themselves directionally in space. As jawed vertebrates evolved even more complex limbs and body organs, they also acquired more complex brain structures and greater cognitive and behavioral sophistication. But the evolution of this psychology occurred as an augmentation and elaboration of ancestral neural systems. And this continued all through the evolution of our species as well--our cognition and emotions are built upon the very primitive neural systems that existed in our primitive ancestors.

This point is extremely important for understanding ourselves. Yes our brains are extraordinary in their size, structure, and capacity, but most of the complex elements within our psychology are elaborations of neural systems shared by all vertebrates. This is also one reason why we can make confident generalizations about our own brain function by doing experiments on the brains and neurons of frogs, mice, and flies—their neural structures are largely analogous to our own. The same generalization also holds with our higher order thinking and emotions; they too are accumulations of many neural elements, many of which are quite ancient in origin. Like the human brain (see Chapter 1) cognition and emotions evolved in a piecemeal, cumulative fashion.

But while we can divide brain functions into these two separate categories of information and motivation, we should not think of them as sequestered entities. In fact, they evolved to be highly interdependent neural systems. A motivational system without any information is highly wasteful just as an informational system without any motivation is pointless. Ideally, a successful animal uses both information and motivation to complement each other to mate or acquire food with the utmost efficiency.

This is something easy to forget. As I noted above, one of the most common misconceptions about the human mind is that our thinking is somehow distinct from our emotions. We like to believe that the human brain is capable of making "cold" evaluations and that human decision-making is based on purely rational considerations. Even today, much of contemporary theory in the social sciences is based on the premise that people behave as largely emotionless, rational actors. In reality, our thinking is fundamentally intertwined with our emotions. There are very parts of animal information systems that are not explicitly connected with motivational systems (and vice versa); in fact, both evolved as interdependent neurological systems.[7] This point is so important, it is worth repeating: animal cognition and emotion didn't evolve to operate in isolation, they evolved to work in tandem.

Consider, for example, one of our most ancient neurological mechanisms, reflexes. When we touch a hot stove, certain nerve cells in our skin are activated by the heat and immediately signal other nerves to make our muscles contract. By themselves, the nerves that sense heat (informative) and the nerves that trigger muscle contraction (motivational) are not very functional. Having nerves that simply registering "hot" isn't very useful, nor is it very practical to have nerves that randomly cause contractions either. But when nerves that sense heat are coupled with nerves that make muscles contract, they become an extremely protective tandem. And it's not just with reflexes where cognition and emotions intertwine—all of our "higher order" brain functions that are also fundamentally interconnected. For example, sadness, hunger, pain, and all other forms of emotion can be triggered not just by smelling a cooking steak or burning one's skin, but by certain thoughts or memories.

And it's not just informative processes that are prompting motivational systems, our motivational systems are fundamentally shaping how we interpret information. In other words, emotions permeate nearly every form of cognition, ranging from our perception to our highest reasoning. Consider, for example, learning and memory. When we train a horse, a dog, or a lab rat, we generally employ positive or negative reinforcement (or what psychologists call operant conditioning): when the animal follows our command, we give it a reward; when it disobeys, we punish it.[8] But what we are doing is actually making the animal have motivational experiences in relation to a particular stimulus—animals learn commands by feeling good when they do what we want and feeling bad when they don't.[9] This is how memories work as well. As with Proust's Madeleine cake, those experiences that contain feelings are much more likely to be stored in our long-term memories than those that do not. We, like all animals, animals learn and remember by feeling.

These motivational systems are also crucial for basic decision-making. Most animals don't have the neural capacity to generate a large "working memory," the part of the human mind that allows us to make reasoned deductions.[10] Instead, animals use combinations of motivational signals to guide their behavior. Imagine, for example, a hungry deer on your lawn. When a deer is deciding whether or not to eat your azaleas, it may seem like it is weighing the benefits of the food relative to the dangers of becoming venison. But, in reality, it isn't calculating the relative probabilities of a predator lurking behind the nearby hedges. Instead, the deer is comparing its feelings of hunger and fear. Whether or not it eats the azaleas ultimately depends on whichever motivational signal is the strongest.[11] Ironically, with these motivational systems, the deer is actually using probabilities in making its judgment, but they are probabilities that have been calculated through natural selection—those impulses that lead to catastrophic outcomes (either being too shy and starving to death or being too bold and getting eaten) are weeded out of the gene pool. Nevertheless, at its root, animal decision-making, like most of our own, derives from motivational impulses. The deer actually "thinks by feeling."

This occurs in humans as well.[12] Most human decisions involve far too many elements to be conducted in a purely rational framework. Our working memory is simply too constrained to consider all the elements that are involved in a decision.[13] Consider how we play chess. Unlike a computer program like "Deep Blue," our brains do not run through millions of calculations when deciding whether to move a pawn or a bishop. To economize our decision-making, our brains employ more efficient processes to direct our choices – a motivational system. In fact, most of what we consider thinking (our "cold, reasoned calculations") are actually post-hoc rationalizations of some initial, motivational impulses. While we'd like to believe that our decisions are made by some clear, rational deductions, in most cases our emotions have already lead us to a decision. What seems like "reasoning" is typically a justification of an emotional directive that has already been made.

This is evident in many common-place behaviors. Say, for instance, you are trying to pick a restaurant for dinner. You could easily spend hours comparing the relative merits of things like price, taste, convenience, ambiance, and so on. In fact, when trying to make a decision, you may believe that your brain is actually weighing all of these different factors. But if you reflect on this choice, you can appreciate how highly unlikely this is. Choosing between a Japanese, Italian, and French restaurant involves so many different elements that it is nearly impossible to make a rational calculation based on evaluating all the different elements. Instead, our feelings guide our choices. Even when we think that we are rationally weighing our choices, in reality our brains are simply trying to cure some ambivalent feelings with a strong dose of rationalization.[14] Ultimately, however, our decision is a gut reaction: "Tonight, I *feel* like sushi!"

Upon further reflection, the importance of emotions to human reasoning makes perfect sense. Our reason is "the slave of passions," as the philosopher David Hume famously quipped, because emotions help us prioritize our thinking.[15] Animals with large, complex brains are continually bombarded with neural signals. The human brain processes about 11 million bits of sensory information every second.[16] It also has a prodigious memory capacity. For instance, the average English speaker has a vocabulary of roughly 50,000 words that can form in any series of combinations. Between all of this sensory input and this large symbolic repertoire, the human brain can generate near innumerable numbers of thoughts. To keep our consciousness from scattering willy nilly, something needs to discipline our higher order cognition. That disciplining factor is typically our emotions. When animals experience emotions like hunger, lust, pain, or fear, their cognitive processes become highly constrained. In fact, emotions partly evolved precisely as mechanisms to focus and direct animal attention.[17]

What's surprising is not simply that emotions guide most of our decisions, but that emotions also influence even our most abstract reasoning processes. Whether we are working on math problems or solving the Sunday crossword puzzle, we are using both our prefrontal cortex as well as parts of the midbrain that release dopamine signatures. Dopamine is a brain chemical associated with rewards and central to many emotional experiences.[18] Thus even as the brain processes high-order symbols and information in a purely "cold" way, it is utilizing affective markers to "warmly" differentiate pieces of information. When we think of numbers, shapes, or patterns, we are assigning certain affective signals to them.

The emotionality of abstract cognition is well-described by mathematics blogger Efrit Freeq:

> "*Even as a solitary activity, mathematics is, for me, intensely emotional, even visceral. A really clever manipulation that makes a difficult problem easy can produce a tingling sensation up the back of my neck and head. A particularly beautiful piece of mathematics can, on occasion, move me almost to tears*."[19]

And if cognition and emotion are fundamentally intertwined with abstract mathematics, we can appreciate how fully interconnected they are when it comes to people and politics. As I'll discuss in Chapter 4, much of our cognition evolved specifically to process social information and social information usually involves emotions. When we think of other people, we think of them in emotionally evaluative terms: do I like them, do I fear them, do I trust them, etc.?

One of the most fascinating examples of how emotions shape our social thinking is found in a rare brain disease called Capgras delusion.[20] At first blush, this disease has rather comical-sounding symptoms: people with Capgras delusion are genuinely convinced that their spouses, friends, or loved ones have been replaced by identical-looking imposters. Although they are otherwise completely rational and lucid, they nevertheless remain convinced that the person who claims to be their spouse or friend is not that person at all. The reason why they sustain this delusion is typically due to damage in the brain region that links facial recognition with the amygdala, the part of the brain that involves many emotions. Because of this brain damage, old and familiar faces suddenly seem foreign, largely because they don't elicit any feelings. The absence of this emotional marker generates so much cognitive dissonance that their minds scramble to reorient their world. In this case, their minds leap at what must be the most logical deduction: since their parent, spouse, or friend no longer "feels" like the right person, then that person must actually be an imposter!

And this same process occurs with much of our broader social thinking. The way we "understand" our social worlds is made fundamentally to be in line with our motivational systems. In other words, how we think about other people or social situations is determined first how we feel about them. This has been well demonstrated in a series of experiments about ethical quandaries by psychologist Joshua Greene.[21] In the experiments, research subjects are told a speeding trolley is about to kill five workers on the track. In one variant, they can flip a switch so the train will kill just one other person instead of five; in another variant, they can push a hapless "fat" man in front of the trolley to stop it. People are far more likely to say its okay to flip a switch than actually push a man in front of the train. And when you look at what's happening inside people's brains you can see why: the idea of actually pushing someone in front of the train triggers some emotional responses that supersede the reasoned utilitarian calculus.[22]

These experiments show how our ethical decisions are informed less by some abstract principles or Kantian categorical imperatives than by unconscious emotional impulses. In neurological terms, when we are faced with a moral decision, we not only utilize the prefrontal cortex, the part of our brain that enables abstract thought, but we also employ parts of the limbic midbrain that generate motivational responses. This is why people with specific brain injuries are unable to engage in basic moral reasoning tasks.[23] Although these subjects retain their intelligence and memories, they lack the feelings that help normal individuals determine their moral judgments. When they are faced with moral dilemmas, they often act with complete insensitivity to others' emotional cues and generate conflict by failing to live up to basic moral norms.

Executive Functions

Such difficult moral dilemmas also raise an important question: what happens when conflicting emotions happen simultaneously? Consider again the example of the deer on the lawn. How does a deer's brain determine which emotion is the strongest? What if its feelings of fear and hunger are equally prevalent? The answer to these questions depends on the complexity of the animal in question. Simple animals don't have a wide range of motivations (mostly reflexes) and thus feel less ambivalence. Physically complex animals have more motivations and thus they have more sources of conflict. Among all animals, there are none more motivationally complex (and ambivalent) than mammals; and, among mammals, there are none more emotionally complex (and ambivalent) than ourselves.

This motivational complexity arises from our sociability. A solitary animal, like a crab or a frog, doesn't experience a lot of emotional conflict. It occasionally may feel conflicting impulses between wanting to eat something and fleeing a predator, but usually it only has to coordinate between its own impulses and a few signals from its environment. Social animals, however, experience a whole new dimension of motivational complexity because they internalize the emotions of others, and these emotions will often be in conflict with their own. To be a social animal is to be an ambivalent one.

This is partly why social animals have larger brains – they need to process more information about others and also coordinate a wider range of emotional impulses.[24] In mammals, these functions occur primarily in the neo-cortex. I discussed in Chapter 1, social mammals have larger neo-cortices probably because they have needs for greater emotional regulation. The neo-cortex is believed to house a suite of advanced mental processes that fall under the heading of "executive function." Although the precise nature of executive functions are still unknown, psychologists speculate that the pre-frontal neo-cortex allows for a broad range of specific tasks including reasoning, planning, working memory, attention, and the inhibition of emotional impulses.[25] In other words, most of our conscious and deliberative thinking occurs as the consequence of executive functions.

It is important to recognize a few important facts about "executive functions." First, the whole notion of "executive function" is still largely theoretical.[26] We don't know for sure that such an entity actually exists or how its various parts relate to each other. We know that lesions to the pre-frontal cortex can impair our ability to reason or our capacity to inhibit other urges, but we don't know how exactly the brain accomplishes these tasks or how they interact with each other. In other words, it is not clear whether the same parts of the brain that help us reason are also the exact same part of the brain that allows us to resist a second helping of chocolate cake.

Second, even within these executive functions, the boundaries between cognition and emotion are quite porous. Yes, our prefrontal cortex allows us to reason, but reasoning rarely exists of its own accord. Once again, most of our reasoning is typically the expression of an underlying emotional impulse. Emotions shape not just what we "choose" to think about, but "how" we think as well.[27] When people are anxious, they are much less capable at performing many cognitive and motor tasks, partly because they become preoccupied with whatever makes them afraid. To put it bluntly: it is far more difficult to play a game of chess if you're sitting next to a sleeping rattlesnake than if you're not.

This point is extremely important for understanding how emotions shape our self understanding. Most of our ideals like freedom, oppression, duty, loyalty, and honor are laden with emotional significance. Many of our moral imperatives like justice and charity are notions understood more by feeling than by thought. The importance of emotions extends to mass politics as well. If politics is largely about getting other people to do what we want, then the best way to do this is to invoke emotions, for emotions are, after all, part of the neurological mechanisms that motivate us. Such emotions not only move us to action, they also direct our thoughts. Philosophers since Aristotle have long recognized that the best way to frame a political discussion is to invoke emotional frames: when citizens are "blind with rage" or "drunk with patriotism" it is far easier to get them to disregard uncomfortable truths or inconvenient facts.[28] Once we recognize that most of our thinking is driven as much by our motivational than our evaluative systems, we'll have a good way of understanding why so much of our behavior seems so bizarre or irrational, at least to outsiders. But in order to do this, we need to examine more closely what these motivational systems really are.

What, Exactly, Are Emotions?

Ironically, a good way to describe our motivational system is with something that's not an emotion at all: our sense of touch. Now if someone asked you to describe how your sense of touch works, you would probably answer that the nerves in your skin each process a range of touch sensations. In other words, most of us intuitively think that each dermal nerve cell can differentiate between smooth, hot, sharp, and stinging sensations. But this is not how our sense of touch operates at all. Instead of being general-purpose feelers, each dermal nerve cell is a highly specialized sensor that only responds to a particular type of stimulus. Some dermal nerve cells respond to pain, others to pressure, and still others to contact or temperature. Within each of these four major groups of sensation, there are even more specific neurons (or what neuro-scientists call nociceptors) that differentiate types of pain, contact, pressure, etc. For instance, a bruising pain comes from nociceptors sensitive to the chemical histamine, while a burning pain comes from nociceptors for other chemical markers. Each of these specific nerve cells then send signals to different brain regions via different neurotransmitters. The softness of a silk scarf feels differently than the sharpness of a pointy stick because different sets of nerves, neurotransmitters, and brain regions are being activated.

The reason I start with this description of touch is that it is a good example of what happens with our motivational systems in general and our emotions in particular. Like our sense of touch, our motivational systems are comprised of combinations of very specific neural mechanisms. The number of these mechanisms and the complexity of their combinations depend on the type of motivation in question. Some primitive motivations, like our reflexes, only involve a few neural mechanisms; later motivators, like our pain centers, involve more complicated arrays of neural mechanisms; and, our most complex motivational systems, like our emotions of guilt, anxiety, or jealously, are comprised of even more complicated neural arrangements. But like everything else that is complex in nature, even our most complicated emotions are built on elaborations of older and simpler elements. Pain and pleasure contain elements of reflexes; guilt and anxiety contain elements of pain, etc. Even when we feel guilty, anxious, or jealous, we are employing many of the same neural mechanisms that are active when we feel pain, pleasure, or even a reflex.

Because this characterization may seem so counterintuitive, let me elaborate with a simple metaphor. For most animals, motivational systems operate like the remote control for a toy car. Imagine this remote control has an assortment of specific buttons and each moves the car in a particular direction: there is a button to go forward, one to go back, one to go left, one to go right, and so on.[29] With just a few buttons, a driver can make the car engage in a wide range of motions and, with some practice, seamlessly weave the toy car around obstacles with apparent fluidity. But even though the car may be executing a series of elegant figure-8's, it is not being directed by a "figure-8" button; instead it is driven by alternately pushing different buttons with different levels of intensity.

Motivational systems work in a similar manner. Animals have a wide assortment of specific "buttons" (i.e., neural processes) that direct their behaviors in particular ways. They also have specific sets of neural sensors that are dedicated to "pushing these buttons" with varying degrees of intensity. When an animal smells food or sees a predator, its response is determined by a specific combination of buttons that initiate particular responses. The sight of a predator will push a "button" to run away but it won't push a "button" to relax or eat. In animals, these "buttons" are actually comprised of various brain regions, neurons, neuro-transmitters, and hormones. And, like the buttons of the remote control, each of these neural mechanisms prompts animals to "move" in a singular way and can be triggered with a particular intensity. The number of these "buttons" and the types of behaviors they can produce depends on the physiological complexity of the animal.

To illustrate this, let us start with a very simple animal, a sea anemone. These lovely creatures do not have a general-purpose thinking device telling it what to do. In fact, they don't even have a brain. Instead, they live according to the demands of a handful of very specialized neural mechanisms that are dedicated to singular tasks. Or, in my terms, they only have a few "buttons." Some of these make them contract when touched, eat prey that come into their tentacles, and reproduce (some sexually, some asexually). They can't, however, really hunt, migrate, seduce, communicate, or socialize like more complex animals because their small number of neurons are dedicated to very specific types of reflexive actions (contracting, eating, inseminating, etc.).

More complex animals like insects and crustaceans have an even more complicated neural architecture (i.e. more "buttons") and thus exhibit a wider array of behaviors. Ants, for example, can forage, build nests, attack enemies, or coordinate themselves in a highly elaborate manner. But these sophisticated activities are still based on sets of singular neural mechanisms; only with ants these singular mechanisms are combined in more complicated arrays to produce more sophisticated behaviors. Thus when an ant builds a nest or attacks an enemy it is using combinations of primitive reflexes and neural mechanisms that can sense its surroundings and direct digging or fighting behaviors. Or, in the terms above, it is "pushing" a larger number of buttons in different combinations to initiate a wider range of behaviors. The accumulation of singular neural mechanisms generally increases as animals themselves become more physically and socially complex.

Which brings us to humans. Although we may perceive emotions like “happy,” “sad,” and “angry” as distinct and encapsulated feeling-states, neurologically this is not really happening. We don’t have an isolated part of the brain that only generates “happiness.” In fact, “happiness” is really just a word in the English language we assign to certain feelings.[30] Instead, emotions that we describe with words like “happiness,” “sadness,” or “anger” are just the result of particular combinations of many different (and sometimes overlapping) neural mechanisms. Indeed, these emotions share many of the same neurological components, even if in total they get us to act in different ways. In other words, happiness, anger, and sadness are activated by some of the same “buttons.” The way to understand our emotions, therefore, is to describe this array of neural mechanisms (or “buttons”) and determine what types of behaviors they evolved to motivate.

This, however, is a very tricky task. In a neurologically complex organism like a human being, there are many brain regions, hormones, and neurotransmitters that have evolved to shape our behavior. THIS IS A SYSTEM WITH A LOT OF COMPLEXITY AND REDUNDANCY. If we were to specify every single biological mechanism that motivates us, we would have a list that would be too long and unwieldy to be of much practice use. In order to comprehend our motivational system, we need to categorize these mechanisms together by virtue of some shared general properties. And the best way to categorize our motivational systems is to generalize about what type of actions they are trying to motivate.

Within psychology, the most widely recognized categorization scheme is the circumplex model of emotion. Although circumplex models come in different varieties, they share a same basic configuration: all human emotions are typically arrayed in a space defined by two (and sometimes three) separate motivational dimensions.[31] A typical example is listed in Figure 3.1. One dimension is usually defined by pleasure (or what psychologists call "valence"); the other dimension by intensity or arousal. Various emotions can then be plotted relative to these two dimensions relative to their valence and intensity. For example, ecstasy and contentment both score high on valence but differ in arousal: ecstasy has high arousal and contentment low arousal. Anger and Fear are both high in arousal but tend to be similarly on the negative end of the valence scale.

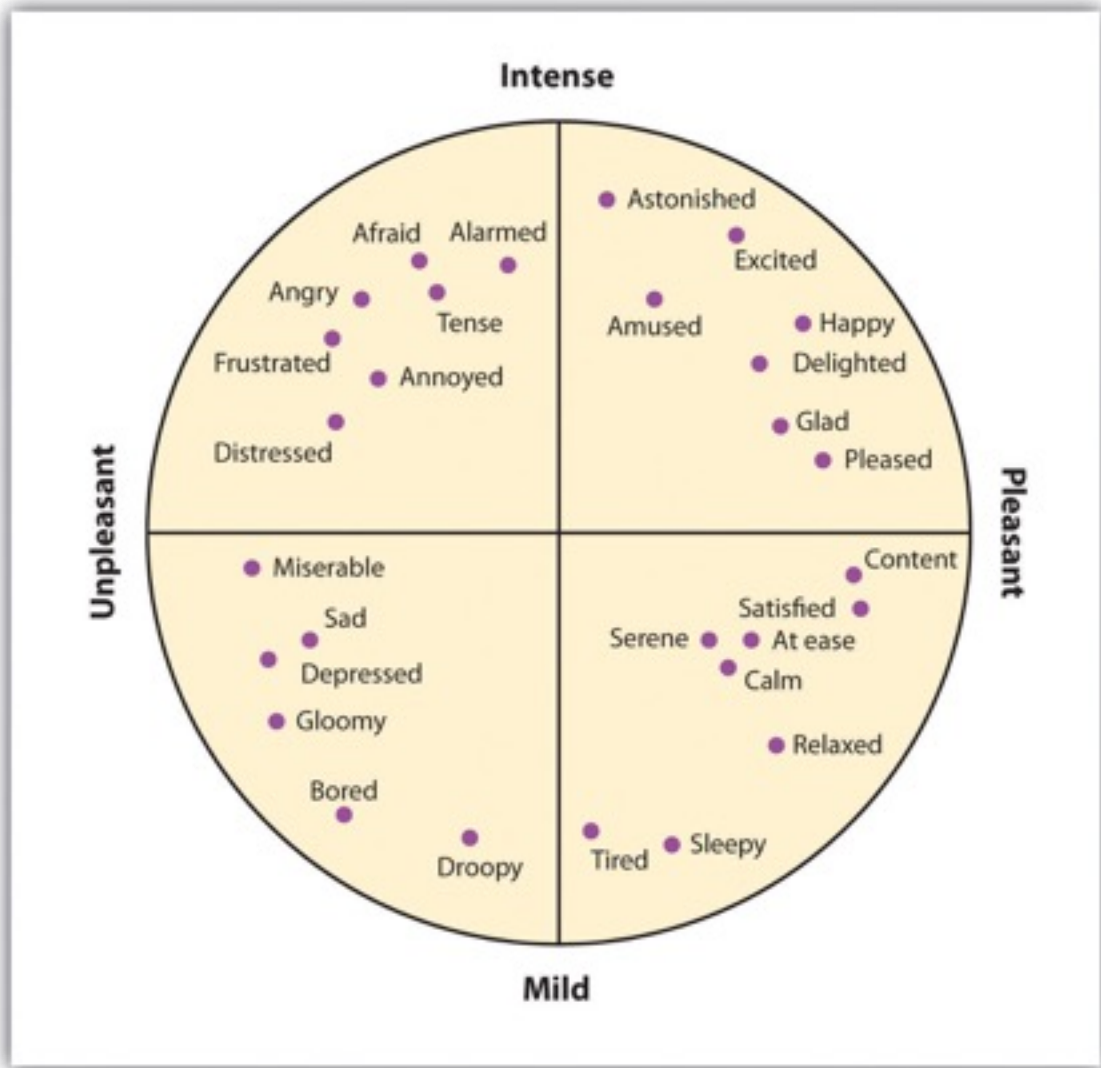

Figure 3.1 – Circumplex Model of Emotion

Undeniably elegant, such circumplex models are useful tools for helping us understand the continual nature of emotions and distinctions among them. But the circularity of this model is also misleading in many key regards. First, they represent valence and intensity as operating on a single continuum. This implies that there is a single neurological mechanism that generates both pleasant or unpleasant sensations or that the same neurological processes work to make us both more activated and relaxed.

But this is not how our brains work. Consider again the metaphor of the remote control. Just as the remote control has a button to go forward and another to go backward, so too did animals evolve separate neural mechanisms that work in opposite directions. For example, excitation and relaxation are triggered by separate systems (e.g., the sympathetic and parasympathetic nervous systems). The same occurs with valence: pain is triggered by specific nociceptors and, in humans, mediated through the Parietal Insular Cortex; pleasure, pain's opposite, is regulated by entirely different neuro-transmitters like dopamine and the activation of still different brain regions. Rather than being opposite ends of a single dimension, it is more accurate to describe pain and pleasure or excitation and relaxation as each being separate dimensions that evolved to work in conjunction.[32] This is why we can sometimes feel pain and pleasure simultaneously or even feel energized yet relaxed. (ALSO NOTE ASsYMETRY BETWEEN DIMENSIONS)

In addition, by assigning each emotion to a particular location within a two dimensional space, the circumplex model depicts a proximity among certain types of emotional states that is often inappropriate or misleading. In the model above, for example, anger and fear are spatially proximate close to each other and both are far away from "glad." But this is not necessarily an accurate portrayal of these states. Yes, anger and fear involve negative feelings and higher excitation, but they motivate us in fundamentally different ways: anger, like gladness, moves us towards the person or thing that is stimulating us; fear prompts us to move away. While anger and fear responses share some brain regions, there are many brain elements in each that are very distinct and they are emotions that work to very different ends.

The challenge, therefore, is to come up with a way of differentiating motivational systems that can economically describe a full range of animal behaviors yet also differentiate among their constitutive elements. Below is an overly simplistic attempt to do just this. As with a remote control metaphor, I have tried to identify a manageable number of “buttons” that would produce a wide range of behaviors. In other words, if I had an “animal remote control” what would be the smallest number of buttons that could generate the largest range of behaviors? In looking for answer, I examined homologous neural mechanisms in other animals and tried to deduce what are general motivational goals that all animals would share. I have settled on an “motivational dimension” model that has eight such “buttons,” which are described in Table 3.1.[33]

The first two dimensions fall under the categories of APPROACH and WITHDRAWAL. In simple animals, like sea anemones or flatworms, APPROACH and WITHDRAWAL mechanisms are reflexes that cause contractions away from harm or stimulate them to move towards food. Interestingly, analogous reflexive impulses are in humans as well: flexors, which make our muscles contract, are basic WITHDRAWAL mechanisms; extensors, which make our muscles relax, are APPROACH mechanisms.[34] In more complex animals like vertebrates, APPROACH and WITHDRAWAL mechanisms involve more elaborate brain regions to differentiating between attractive and repulsive stimuli.[35] Disgust, for example, utilizes a number of WITHDRAWAL mechanisms located in the insular cortex.[36]

Despite their evolutionary primacy, the APPROACH and WITHDRAWAL dimensions also include many include neural mechanisms that are rather late evolutionary adaptations, particularly those related to “executive functioning.” For example, we may feel a strong urge to eat a piece of chocolate cake, but simultaneously feel other emotions that keep our urges in check; these inhibitory mechanisms would fall under the WITHDRAWAL category. In large-brained mammals like ourselves, such mechanisms typically include regions of the right prefrontal cortex that work to inhibit emotional impulses.[37] Meanwhile, APPROACH mechanisms in the left prefrontal cortex can also override other emotional signals, such as when a shy person intentionally makes eye contact or generates the courage to jump off the high dive.

Once animals evolved neurons that made them move towards and away from other things, they evolved mechanisms that helped them better modulate their own behavior and to learn from their environment. These neural mechanisms fall under the categories of PAIN and PLEASURE. These dimensions include traditional mechanisms that evaluate sensory information such as nociceptors or opioid receptors.[38] But PAIN and PLEASURE also include neural mechanisms in learning, memory, habits, and other instinctual drives.[39] For example, when we bristle at certain thoughts or savor the anticipation of a good meal, we involve neurotransmitters like dopamine and utilize regions of the forebrain and hippocampus.[40] In other words, PAIN and PLEASURE mechanisms encompass not just immediate sensory feelings but also more subtle drives that make us want to do a specific task. The discomfort of hunger motivates a search for food, the anticipation of orgasm drives the urge to mate, the pangs of loneliness stimulate the need for social contact, and so on.

Next are two motivational dimensions that regulate an animal's energy state, what we can call ACTIVATION and DEACTIVATION. These neural mechanisms emerged as early vertebrates began evolving circulatory systems.[41] These neural mechanisms get animals ready for action, help them adjust their metabolism and body temperatures, and regulate circadian rhythms of sleep and hunger.[42] In complex animals like mammals, ACTIVATION and DEACTIVATION mechanisms range from glutamate receptors in the brain stem (that adjust breathing and heart-rate) to hormonal releases in the hypothalamus that affect sleep and appetite. EPIPHEDERINE AND NORAEPIPHEDERINE.

The final two motivational dimensions are neural mechanisms that deal with animal sociability, what I group under the labels of EMPATHIZE and INDIFFERENCE. These neural mechanisms are most fully realized in mammals and their functions are primarily located in regions of the forebrain. The neural mechanisms that fall under the EMPATHIZE category are those that produce attention to others' emotional states. For example, empathy is partly contingent on hormonal neurotransmitters like oxytocin and vasopressin activating cells in the amygdala and neo-cortex that is found in most mammals.[43] [IN SOME WAYS THIS IS SENSITIVITY TO OTHER ANIMALS EMOTIONAL STATES – THE EXTENT WE INTERNALIZE THEIR MOTIVATIONS AS OUR OWN]. INDIFFERENCE works to inhibit other emotional signals, especially the emotional resonance with other animals. This can occur through the inhibition of neurotransmitters like serotonin or through the deactivation of neo-cortical brain regions.[44]

TABLE 1 – AFFECTIVE DIMENSIONS THAT COMPRISE EMOTIONS

Affective Dimension	Sample of Neural Mechanisms
WITHDRAWAL	Reflexes, Right Prefrontal Cortex
APPROACH	Left Prefrontal Cortex
PAIN	Nociceptors, Lamina I cells, Parietal Insular Cortex
PLEASURE	Dopamine, Nucleus Accumbens, Prefrontal Cortex

ACTIVATION	Reticular Formation, Sympathetic Nervous System
DEACTIVATION	Thalamus, Parasympathetic Nervous System
EMPATHIZE	Oxytocin
INDIFFERENCE	Seratonin

Once again, this list is not meant to be definitive nor exhaustive – we could categorize the many neural mechanisms that motivate animal behavior in any number of ways. And, within each of the listed dimensions, there are numerous sub-dimensions that shape behavior in more subtle ways. Nevertheless, from this short list, we can see how various combinations of these motivational dimensions can generate so many different feeling states and prompt such a wide range of behaviors. As I've illustrated in Figure 3.2, any particular emotion for which we have a word can be re-characterized as a distinct combination of these underlying neural mechanisms.

Take the example of anger. The English term "anger" derives from the Old Norse word *angr*, which initially referred to trouble, pain, or affliction. Aristotle defined anger (or the Greek *orge*) as "an impulse, accompanied by pain, to a conspicuous revenge for a conspicuous slight … it must always be felt towards some particular individual. It must always be attended by a certain pleasure."[45] Contemporary definitions are quite similar, characterizing anger as an emotional state stimulated by the perception of some "wrong" and involving an impulse to rectify this wrong, usually with an aggressive behavior.[46]

From these definitions, we can see how neurologically complicated "anger" really is. First, anger involves arousal, so it should include neural mechanisms under the category of ACTIVATION; second, anger also involves an internal state of discomfort, so it involves an activation of PAIN mechanisms. Third, anger reduces our empathy with others, so anger will involve DESENSITIZE mechanisms. Fourth, anger typically draws us towards whomever we're angry at, usually as a precursor to some aggressive act, so it scores relatively high on the APPROACH dimension. Finally, when anger is acted upon, it provides a release, which is the activation of both the parasympathetic nervous system and opioid receptors, i.e., PLEASURE.

Although this is a highly simplified and stylized description, like any model, it also provides a useful way of understanding a complex phenomenon. And, neurologically speaking, human emotions are very complex phenomena. Returning again to the example of anger, we can see how a response to an insult will be a multifaceted neural state that involves several contradictory impulses. Anger involves many different brain regions and neural processes operating simultaneously, like PAIN and PLEASURE, sometimes at cross-purposes. Anger also invokes a wide range of brain regions: some, dealing with APPROACH and PAIN, extend far back down the evolutionary tree; others, like DESENSITIZE, are more recently evolved. And, we can better see emotions like anger contrast not only with other "primary" emotions like fear or happiness (as depicted in Figure 3.2) but also with similar emotions like fury, irritation, and annoyance.

Even more interestingly, this multi-dimensional model allows us a vantage point upon which we can reflect on emotional processes that are not available to our conscious awareness or that are outside of our linguistic repertoire. Just as we are largely unaware of our emotional experiences, most of us are probably unaware of all the elements within our own lived experience. Partly this is a problem of consciousness—our minds are quite limited in what they can focus on at any given time. Distracted by the mundane tasks of the world, we spend much of our time simply unconscious of the motivational states that are steering us through the day.

And partly this is a problem of language and culture. As English speakers, we have a lot of words (roughly 3,000) to describe our emotional states, yet even with all of these terms, there are still many emotions for which no English words exist. English is still a young language and many words for emotions are relatively recent inventions.[47] When English words don't exist for an emotion, we sometimes borrow from other languages: *schadenfreude* is a German expression for getting pleasure at someone else's misfortune; *litost* is a Czech term describing the feeling humiliated by the sight of your own misery. But clearly there are other emotional experiences that go unrecognized because there are not words to describe them.

One such "unlabeled emotion" that I've long wondered about is the state of being simultaneously attracted to someone and repulsed by them at the same time. In the affective dimension model, this would mean scoring high on APPROACH, WITHDRAWAL, and ACTIVATION mechanisms all at the same time. I have two friends who seem to trigger this in each other. They always express a high degree of mutual loathing yet they also have this very palpable sexual frisson. Although they are perpetually disparaging one another, they never seem to miss an opportunity to be in each other's company and are visibly aroused by the other's presence. For years I've searched for a word in any language that describes this particular state (German seemed like a good candidate for having such a word) but so far I've yet to find one. Yet I think this state of being simultaneously attracted and repulsed by someone is not uncommon either. In fact, it may be even more common than we realize but, because we don't have a word that describes it, it goes largely unrecognized.[48]

One great benefit of a dimensional model of emotions is that it provides us with the power to speculate about emotions in ways that transcend our immediate linguistic limitations. Remember, all it takes to trigger an emotional response is the right stimulus. While our language has words for many common types of emotional responses, there may be numerous combinations of unusual stimuli that push our "motivational buttons" in uncommon ways, such as when something gives us simultaneously high levels of both pain and pleasure. By anticipating how certain stimuli may trigger combinations of these dimensions, we can begin to specify the neural mechanisms that define human nature and better understand the rich, multifaceted nature of our own emotional experiences. But before we go further, we need to examine another key aspect of human motivation: temperament.

EMOTIONS, TEMPERAMENT, AND HOMEOSTASIS

"Nothing tastes as good as skinny feels." – Kate Moss

*M*ost Americans believe that being thinner will make them happier. Yet, despite the billions of dollars annually spent on weight loss products, diet plans, and self-help books, relatively few people are able to either shed pounds or make themselves more contented. Why are both weight-loss and greater happiness such elusive goals? The answer is to be found in a biological process that is at the heart of animal motivation systems and human emotion: homeostasis.

Homeostasis refers to the balance of energy and activity within our bodies. All animals have a homeostatic "set point," a steady state of energy, temperature, metabolism, and behavior that their bodies try to maintain. When they deviate from this set point, their bodies trigger physiological and psychological responses that try to bring them back in balance. When our bodies experience fatigue, we feel tired and seek rest; when we're low on energy, we feel hungry and seek food; when we are cold, we shiver to keep warm, etc. In contemporary examples, probably the best-known homeostatic set point is our weight. Adult human bodies are accustomed to maintaining a certain mass. When we deviate from this weight, such as when we go on a diet, our bodies automatically increase our appetites and decrease our metabolisms, thus resisting our efforts to shed extra pounds. This is why dieting itself is often so unpleasant (our bodies are motivating us to eat) and also why so many people gain weight back after going on a diet--their body has adjusted its metabolic set point to a traditional weight level and works hard to reclaim it.

But homeostasis does not simply apply to our weight, it applies to *all* of our motivational systems as well. Animals regulate their energy levels not just through metabolism and body temperature, but by modulating their behaviors. Some animals are continually frenetic and others tranquil, some are social and others solitary, some are relentlessly inquisitive and others shy. These behavioral dispositions partly arise from a "set point," the base-line state for all of the numerous neural mechanisms that constitute each of the motivational dimensions. For example, an animal with a high PAIN set point is a highly sensitive animal, quick to feel discomfort and react to any stimulation of a nociceptor. An animal with a high WITHDRAWAL set point would be quick to contract upon touch or flee from unrecognized noise. The relative position of any of these set points varies across species. Rabbits, we might say, have high ACTIVATION and WITHDRAWAL set points, continually hopping about and on the alert; sloths have high DEACTIVATION and low ACTIVATION set points, languidly hanging from trees and an waking only to nibble on leaves.

These motivational "set points" are the product of natural selection. Over hundreds of millions of years, animals have evolved ways of living that are the least inefficient for their body traits and environments and homeostasis is the expression of the equilibrium. Evolution may not necessarily optimize an animal's design, but it relentlessly punishes inefficiency. Over time, different species thus evolved set points that are most in line with their ecology. For example, rabbits evolved a higher ACTIVATION set point because they are subject to constant predation and always need to be on alert; sloths, on the other hand, evolved a high DEACTIVATION set point—their ecological strategy is to conserve the limited energy they get from tree leaves by sleeping a lot. Although animals may still experience a particularly sharp motivational state at one time or another, homeostasis will eventually return them to their set point. And, from an evolutionary standpoint, this makes a lot of sense. If an animal spends too much time in an inappropriate emotional state, it will waste energy and be less successful. A rabbit that is too slothful will be eaten; a sloth that is too frenetic will starve itself, etc.

Now actually, it is something of a misnomer to say that each species has a motivational set point; it is more accurate to say that each species has an *average* emotional set point and within any species there is a range of emotional set points that vary by individual. Rabbits may have a high ACTIVATION set point but not all rabbits are equally frenetic – some are likely to be more tranquil than others. Moreover, some rabbits may be shy and have a high WITHDRAWAL set point while others are bold and have a high APPROACH set point.

The accumulation of an individual's set-points is what we may refer to as temperament. When we talk of an animal's temperament, what we are really describing is the cumulative position of all their base line motivational states. An animal with a friendly yet fidgety temperament, for example, has higher APPROACH and ACTIVATION set points, an "emotionally cold" person may have higher WITHDRAWAL and DESENSITIZE set points, and so on. This variation depends partly on an animal's neural complexity. Simple animals only have a few affective dimensions and thus a limited range of set points. This also means their temperaments don't vary all that much. Complex animals have more affective dimensions (and a greater variety of neural mechanisms within each dimension). As a result, they have a greater temperamental variation. In other words, sea anemones all have mostly the same temperament, frogs have a little more temperamental variety, and dogs have a wide temperamental range.

All of this applies to human beings as well. Like every other animal, our species evolved an average range of motivational set points. Human temperament evolved to be the most efficient for balancing between our hominin ancestors' physical capabilities and their environments. As they began walking upright and becoming more social, their emotional set points evolved relative to their surroundings and physical capabilities. Most importantly, as I suggested in Chapter 2, it is quite likely that once our species acquired language, it experienced a high level of selection on certain temperamental traits; specifically, our ancestors' average temperament probably shifted to a higher set point of EMPATHY and APPROACH.

Which brings us back to happiness. Psychologists have long observed that people tend to have a set point with respect to their overall level of happiness, what they refer to as the "hedonic treadmill." Throughout the vicissitudes of life, people continually return to a particular state of subjective well-being. Even after some major event, such as winning the lottery or losing a limb, people generally revert back to the same level of happiness they had before. In the long run, our bodies and minds have particular baseline levels of PLEASURE, ACTIVATION, and so forth that they continually work to reclaim.

And what determines a person's motivational set-points? Like all our psychological traits, temperament comes from the *combination* of genes and environment. The extent of this combination depends on the complexity of the animal. In simple animals, temperaments are narrow in variability and are largely heritable. Just as sea anemones don't have a wide range of individual temperaments, their temperaments aren't as susceptible to environmental changes.[49] A sea anemone is not going to become more "neurotic" because its surrounding water gets suddenly colder. Among more complex animals, environments have a greater impact, although the relative influence of genes and environment is still not clear. Most temperament research has focused on human subjects and the general importance of genes has been well-established although not clearly demarcated. For example, research comparing identical and fraternal twins indicates that anywhere from 20 to 60 percent of differences in individual temperaments are due to genes, depending on the trait in question and how it's measured.[50] Other studies show that temperamental traits that are evident in early childhood largely persist throughout the adult lifespan.[51]

But while these findings suggest that genes matter, they are less helpful in specifying the ways that they do. At this point, we have only identified a few key genes that significantly relate to temperament.[52] These tend to be the genes (or the parts of genes called polymorphisms) that regulate certain neurotransmitters. For example, the DRD4 gene affects dopamine reception in the brain. Because dopamine is such a crucial neuro-transmitter influencing social behavior, learning, and reward-seeking, variants in the alleles of the DRD4 gene can be linked to a wide range of behaviors ranging from alcoholism to novelty seeking.[53] Another genetic marker with large behavioral effects is 5-HTTLPR. This polymorphism is part of a larger gene associated with serotonin, a crucial neurotransmitter. There are at least 14 alleles of 5-HTTLPR and these variations have been associated with a number of temperamental differences such as fearfulness, shyness, and aggression.[54]

That noted, we still know relatively little about the neurological and molecular bases of human temperament. Once again, this is largely because human temperament is an incredibly complex phenomenon. Remember, in a highly social animal like humans, our motivationonal set points are the consequence of many, many distinct neural mechanisms. Each of these neural mechanisms, in turn, is the consequence of numerous hormones, neurotransmitters, and genes working in distinct combinations. Roughly estimating, psychologist Jerome Kagan calculates that "at least 1,400 neurochemical profiles, reciprocally influencing each other, could form the biological bases of human temperaments."[55] To complicate this further, many of these genes may only become activated with particular environmental cues. In short, temperament is not the product of a single gene or even a set of genes, but of numerous combinations of genes whose activations change in response to their environments.

Then there are the direct effects of the environment itself. Our surroundings are constantly changing our brain chemistry and neural connections. As I noted above, the numerous neural mechanisms that underlie both our emotions and our temperaments evolved to direct our behavior in specific ways. But they evolved to be sensitive to the environment. If we are in an environment where our emotional "buttons" are continually being activated, our short-term temperament (our mood) will change. The longer we are subjected to an emotionally potent stimulus, the more our neural chemistry will be altered and the greater the possibility of recalibrating our emotional-set point: put us in twenty minutes of traffic and we may get frustrated, put us in a 2 hour traffic jam and we fly into a rage; put us in 36 hours of continual traffic and we may have a complete mental breakdown.

The impact of environments is most blatantly evident with psychoactive drugs and alcohol. In the short run, these substances change our moods by altering our brain chemistry: alcohol inhibits glutamate and stimulates dopamine; anti-depressants inhibit the reuptake of serotonin, amphetamines increase dopamine and norepinephrine activity, LSD affects glutamate and serotonin in the prefrontal cortex, cocaine and heroin act on opioid receptors, and so on. The immediate effect of these chemicals is to induce strong emotions that may be completely inappropriate to our surroundings. Cocaine, by triggering a big rise in dopamine, will make us feel inordinate pleasure for a short time, even if we are in a setting that would ordinarily make us miserable. Over the long run, however, the continual drug use will alter our brain's chemistry and our homeostatic set points. In the case of cocaine, the brain's threshold of dopamine increases, i.e., its PLEASURE set point rises. Once this happens, an addict will need to find experiences or substances to trigger a large dopamine release just to feel normal. The absence of this high drives the addict into an emotional tailspin. This changing set point is partly why drug addiction has such a big impact on a person's temperament.

The environmental influences on our temperament also come from our daily experiences. From early childhood until death, circumstance constantly moves our motivational set points. This can occur in ways both subtle (the emotional maturation of a child) and profound (chronic stress during wartime). Consider, for a moment, the latter. When someone's trying to stab, shoot, or kill you, several of your brain regions, such as the hypothalamus and adrenal cortex, release large amounts of cortisol, norephinephrine, and serotonin. These hormones and neurotransmitters prepare your body for action, making your heart beat faster and generally making you more alert and sensitive. Once the threat disappears, homeostasis would eventually rebalance your body chemistry and return you to your ordinary temperament. If, however, someone is shooting at you all the time, then these same neural mechanisms get activated again and again. Over time these experiences will begin to influence your temperament. Much as with continually taking psychoactive drugs, traumatizing experiences that flood the brain and body with a disproportionate amount of neurotransmitters and hormones will, over time, alter our ordinary brain chemistry. This is why depression and post-traumatic stress disorder so often arise in survivors of war.

Interestingly, this view of temperament also gives us a new perspective on a wide array of mental problems. Many phobias, neuroses, or mood disorders are really just inappropriate motivational states. Some of these come from bizarre mental associations, such as when people develop an irrational fear of flowers or trees. But many neuroses arise from the accumulation of daily experiences. In everything from our parents' styles of childrearing to our encounters with peers, human development is about establishing a particular homeostatic set point. For example, someone brought up in a home where physical abuse is both frequent and arbitrary may experience an elevated set point around dimensions of WITHDRAWAL and ACTIVITATION. As adults, their temperament will be overly anxious and they will live in a perpetual state of fear or anger.

In modern psychology, few thinkers have focus more attention on the habituation of inappropriate emotions than Sigmund Freud and John Bowlby. Both Freud and Bowlby clearly grasped that the power of our childhood experience comes in the way it fundamentally shapes our later emotional life. For Freud, childhood is when we internalize our parents' expectations about how our emotions should function. In Freud's view, this internalization was driven mostly by the inhibition of sexual impulses, aggression, and bodily functions. But, in retrospect, it appears that Freud sold himself short--human emotional development is not limited to merely the socially problematic emotions like lust and anger, but also to feelings of attachment, loss, curiosity, and many other sentiments as well.[56] SAY MORE ON BOWLBY HERE. Our emotional set points are defined by the habituated patterns we acquire in our own life experience.

Social Homeostasis

Of course, its not just big events or childhood that can shape our temperaments—ordinary social life can affect our temperaments as well. This relates to a process I call *social homeostasis*. Just as individuals have emotional set-points, so also do groups. When we congregate together, we adjust our emotions to be in concert with each other. This happens in our interpersonal relationships, informal groups, and with culture writ large. And it is precisely with social homeostasis where our biology and cultures come together to shape human nature.

Let me explain. As with other social mammals, homo sapiens evolved numerous biological and psychological mechanisms that make us emotionally interdependent. Take, for example, our eyebrows. These incongruous patches of hair do more than simply keep the sweat from our eyes, they are an incredibly efficient way of communicating our emotional states to other people. Think about emoticons. By simply changing the angle of just a few lines with in a circle, these crude symbols can easily communicate a wide range of emotional states: point the "eyebrows" down towards each other and you convey anger or disapproval; point them outwards to express sadness or sympathy. Our ancestors didn't evolve such expressive faces for their own amusement; indeed, until the invention of mirrors, people were largely unaware of their own facial gesticulations. Instead, our ancestors evolved expressive faces because they had a receptive audience in other people.

And this reception depended on a suite of psychological mechanisms that make us highly responsive to others' emotional cues.

In fact, there are few triggers of our own emotions more powerful than other people's feelings. Think how much a crying child can solicit our concern, a cheerful stranger can elevate our mood, or a grieving friend can evoke our solemnity. Although other people's emotions can move us in the short run, their ultimate impact depends on how it relates to our own temperament. Sometimes another person's mood can help us regain emotional homeostasis, such as when someone comforts our sadness or assuages our anxiety. But some times, other people's emotions are taxing precisely because they pull us away from our own motivational set points. "Hell is other people" as Jean-Paul Sartre famously noted, mostly because of the emotional costs they exact. To be with someone who is inordinately sad, angry, or even cheerful, is taxing precisely because their moods upend our own emotional balance.

This emotional feedback occurs not just in close encounters, but among larger social groups as well. From book clubs to football games, human groups have their own motivational set points, a shared temperament that is considered appropriate for the occasion. Funerals demand a somber disposition, comedy clubs an irreverent one, a lynch mob a spiteful one, and so on. People who fail to bring their own emotional state in line with the group typically face ostracism and censure, from both others and from their own internal feelings of dissonance. Giggling at a funeral or weeping at a comedy club is a transgression that invites scorn from others and discomfort among the giggler or weeper. In this way, groups and cultures create their own motivational set points. People who experience inappropriate feelings face strong pressure to bring their emotions in line or to simply leave the group. Conversely, if a large enough portion of a group starts feeling a distinct emotion and it reaches a tipping point, then the entire mood of the group can change. Imagine, for example, if twenty people at a funeral start giggling—sometimes that is enough to make the whole ensemble change its emotional tenor.

Such demands on mood are formalized in human culture. Although we tend to think of culture primarily in terms of technologies or practices that provide a cold utility or a set of social customs, many aspects of human culture function primarily to influence emotional states. Spears, clothes, and huts may help feed and protect us, but art gives us pleasure, religion assuages our fears, and ritual provides social cohesion. From Neolithic shell necklaces to Egyptian pyramids, from courtly manners to libations, human culture is filled with tools and practices whose primary function is to make us feel particular ways.

Once again, there are few thinkers who understood this as profoundly as Sigmund Freud. Throughout his later writings, Freud lamented the psychic toll of culture and civilization. Civilization may protect us from nature and each other, but in Freud's view it comes at a cost to our emotional homeostasis. The ego and superego, those two edifices central to the Freudian psyche, are expressions of adjusted emotional set points. When children are trained to inhibit their excrement, sexuality, and aggressive impulses, they internalize their culture, making its norms and standards part of their own psychology. For Freud, this proved to be a devil's bargain: in exchange for the order and beauty that civilization brings, the modern mind reels in a state of perpetual anxiety and neurosis, or what I might call a maladjusted set point. In this way, culture not only makes us police our own impulses, but binds us together in a shared temperament. Religious laws, civic rules, ancient taboos, sacred totems, and other devices all work to keep our emotions in check and to bring our temperaments in line. If we all share a similar state of repression, neurosis and anxiety, we all share a similar temperament, maladjusted as it may be.

Whatever misgivings we may carry about Freud, many of his observations about culture and temperament were prescient. As I argued in Chapter 2, one of the first things that happened after humans started speaking is that we started grouping together based on the shared temperament of docility. Language domesticated us partly by selecting on a few temperamental traits. Culture only exacerbated this process of social homeostasis. When tribes or civilizations adopt rules, rituals, and laws, they aim to bring their members together into a shared emotional realm. Social cohesion comes not simply by acting the same way, but by feeling the same way as well. The power of icons, flags, and other symbols comes in the sense of commonality of an emotional experience. When we generalize about the emotional tone of various cultures, whether it is the reserve of the Inuits or the exuberance of the Italians, we are tapping into the shared temperament that its practices and folkways instill within its peoples.

This leads us to the art of political communication. As we'll explore in subsequent chapters, the emotional processes and temperaments described above are at the heart of political rhetoric. When political leaders incite others to vote, protest, rebel, or go to war, they draw on emotional mechanisms and symbols that psychologically link their people together. This collective temperament determines how far the political leader can go: it is probably easier to incite the war-like Ache people to violence than the more equanimous Tibetans. Nevertheless, by identifying the neural mechanisms that constitute our emotions and the ways that cultures and social practices adjust the set points of these emotions towards their own ends, we can begin to understand how biology accounts for much of our political behavior. Before looking at this in more detail, however, we need to examine the other crucial aspect of our psychology: how we process information.

[1] http://www.nature.com/news/neuroscience-idle-minds-1.11440

[2] Although some a few thinkers, notably Adam Smith and David Hume, saw them as fundamentally intertwined.

[3] This definition is consistent with the etymology of the term from its Greek/Latin roots of cognosco (con "with" and gnosco "knowing").

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[29] Moreover, imagine we also have one of those fancy remote controls where the speed and turning radius of the car can be modulated by the order and intensity to which the driver presses each button: press the forward button harder to go faster, softly to go slower.

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[31] Robert Plutchik notably adds a third dimension of intensity to his model.

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[33] As will be evident, this model is mostly a small elaboration of the circumplex models mentioned above. And it is also a rather arbitrary and probably incomplete categorization scheme. We don't yet know the full array of specialized neural processes that guide our behaviors (there are likely to be thousands). We could easily list more dimensions than what I have here and some specific neural processes can fit within several categories. Nevertheless, the object here is to come up with a simple model that can help us better identify the neural substrata that underlie our complex emotions.

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[35] Roth, 2013.

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[48] I invite any reader who knows of an existing term for this state to contact me and we can try to introduce it to the English language!

[49] CITE RESEARCH IN TATTERSALL BRAIN BOOK>

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