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On the Evolution of Human Motivation: The Role of Social Prosthetic Systems

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This chapter develops an analysis and set of speculations about social evolution that provide a new way to regard some aspects of human motivation. The theory proposed here hinges on the concept of social prosthetic systems, *which are human relationships that extend one's emotional or cognitive capacities. In such systems, other people serve as prosthetic devices, filling in for lacks in an individual's cognitive or emotional abilities. Social prosthetic systems can be short-term (created to accomplish a specific task) or long-term (part of enduring relationships). According to this theory, humans are motivated to behave in ways that create, extend and support social prosthetic systems, in part because the "self" becomes distributed over other people who function as long-term social prosthetic systems. Moreover, some human behavior may be directed toward establishing conditions that will induce others to serve as one's social prosthetic systems. Implications and predictions of this theory are explored.*

An interesting consensus emerged from a symposium at Harvard's Kennedy School of Government in 2002, still in the direct shadow of the attacks of September 11, 2001. The experts agreed that education per se would not reduce the threat of terrorism in the world, that it was rooted instead in something far deeper – a need to be valued and respected. I won't go through the details of their reasoning here (which included the fact that most of the terrorists who participated in the September 11th attacks were well-educated), but the experts' basic message struck a chord. When it comes to life-organizing decisions, our motivations are not simple. Religion, for example, motivates us to behave in certain ways, and it's no accident that religion plays such a central role in most of the world's current conflicts. In fact, some people place priority on actions that they perceive as important to their group as a whole, even if -- as too-often demonstrated by the suicide bombers in the Middle East -- that action actually ends their lives.

As many have noted, at first glance such behaviors might seem flagrantly to disregard the most basic goal of evolution by natural selection: self preservation. If each of us is a bundle of "selfish genes," as Dawkins maintains, Maslow's famous theory of a hierarchy of motivations should hold: People should focus first on survival, minding essential biological functions, and only thereafter be swayed by more abstract motivations. But we need do no more than read the newspapers to realize that this just isn't so.

In the same vein, the general problem of altruism has been a perennial burr in the side of evolutionary psychology. If the point is to propagate one's own genes, why would one ever hold others' interests above one's own? One possible account centers on the idea that animals behave in such a way that propagates the genes they carry -- even if these genes are harbored by another individual (Hamilton, 1964). This idea can explain why one would sacrifice oneself for two brothers or eight cousins, because of the number of one's genes they share. But how can we understand why someone would sacrifice oneself for total strangers? What sort of motivation would overcome even the urge to survive?

In this essay I explore one possible way to address this vexing problem. I will assume that natural selection is not focused solely on the individual, but also on the group. Ask yourself: How useful would language be if only one person had it? About as useful as the internet if only one computer existed in the world. But it's more than that, language has both productive and receptive aspects, and both had to be tailored in expectation of the other: We speak in ways that can be properly registered by others, and others speak in ways that we can understand. Language, be it serious discussion or aimless jabbering, is a group activity. And thus language had to evolve in the context of the group. But this observation only scratches the surface. I want to argue that in a very deep sense we have been shaped by evolution not only so that we work well in groups, but also so that our personal identity depends on our relationships with others.

The World in the Brain

Evolution by natural selection has given birds hard beaks and aerodynamically designed wings, fish fins, and ivy the ability to orient towards the sun. Evolution by natural selection has given us humans hands and an upright posture -- but more powerfully, it has made us the most adaptable creature on the planet. And we owe our extraordinary adaptability to our brains. It's no exaggeration to say that the brain is the body's most flexible organ. This flexibility in part is the flipside of a limitation: We simply don't have enough genes to program the brain fully in advance. So, like most other animals, both the function and structure of our brains are not entirely determined by our genes, but instead depend in part on characteristics of the environment in which we find ourselves.

Here's a concrete example: We determine the distance of objects partly by using information from our two eyes. Look at an object that's within 10 feet or so of where you are sitting. Now cover one eye and look at it; now cover the other, and look again. The image should seem to shift slightly as you change eyes. Because your eyes aren't in the exact same place on your face, they each have different views. A process called *stereovision* makes use of these differences to compute how far away something is (the difference becomes smaller for objects that are farther away; e.g., see Pinker, 1997). And here's the interesting point: The precise difference in the views from the two eyes depends on exactly *how far apart the eyes are* – but there's no way the genes can "know" that in advance. Depending on the mother's diet before birth, and the child's diet thereafter, the head will grow at different rates; the precise distance between the eyes depends partly on environmental factors, which cannot be anticipated in advance by the genes. Thus, it's not really a question of having to make due with limited numbers of genes; even with an unlimited number of genes, it's impossible for the genes to program exactly how the brain should carry out stereovision.

So, how does stereovision develop? The solution hit on by the genes is exceedingly clever and remarkably simple: The genes simply overpopulate the brain with connections, some that will work properly in one scenario, others that will work properly in another, and so on. Over time, the outputs from some neural circuits provide estimates of distance that successfully guide reaching, eye movements, and the like, and the outputs from other circuits turn out not to be useful. In the case of stereovision, the circuits that provide useful information about the environment survive, and the others are eliminated ("pruned" away; for a recent overview, see Huttenlocher, 2002). Just as the muscles of the legs were configured by natural selection on the basis of the "assumption" that gravity exists (and thus we don't need as much strength to put our legs down as to lift them up), the brain evolved with the "assumption" that it would exist in a world of three-dimensional objects. In other words, the genes have been selected to produce a brain that in turn can be shaped by the environment in specific ways.

In fact, our heads are stuffed with extra neural connections all the way up to about age 8. The environment (including its indirect effects, for example on bone growth) literally sculpts our brains (cf. Comery et al., 1996; Kleim et al., 1998; Merzenich et al., 1983). In my view (and to my knowledge this has yet to be tested, but I'll bet on it), this sculpting occurs not simply because we move around and interact with physical objects (which tunes our visual and motor systems): It also occurs because we learn language -- and all the concepts and attitudes embedded in it -- from others and are bathed in a full cultural array of practices and procedures, beliefs and bylaws. Such early experience leads us to carry the world within us; the boundaries between "the world" --and especially the social world -- and "us" are fuzzier than they might appear.

The implications of the idea that the environment sculpts the developing brain are far-reaching. For example, the Austrian Philosopher Ludwig Wittgenstein (1999) asserted, "If a lion could speak, we would not understand him." What he meant by this was that lions have a different "form of life" than humans – they run on four legs, try to bring down antelope, must navigate through tall grass, and so on, whereas we are bipedal, manipulate objects with our hands, live largely in a carpentered world, and so on. The concepts needed to negotiate the two environments shaped the brains of the species (lions and humans), and because the environments are so different, the concepts would be too. And thus the lion's words would rely on different concepts than we have, which are rooted in the very structure of the brain. I wonder whether this might figure into an explanation of why at least some "wild children," such as Wild Boy of Aveyron and his contemporary counterparts, could never be taught to communicate well with other people (Newton, 2002). These children were never socialized, either growing up solely in the company of lower animals or virtually isolated from all forms of social contact.

In summary: The point I want to make here is that the boundary between the brain and world is blurred. Although genes hard wire the brain so that it can develop in specific ways (to have stereovision, use language, and so on), the genes build a brain that can develop in numerous ways. The brain is "initialized" by the environment in which it finds itself, allowing it to conceptualize and function within that environment.

But what does this have to do with why we are motivated in some ways but not others? To see the link, we first need to look at the brain/environment relation from the other direction, not the world in the brain but rather the brain in the world.

The Brain in the World

My key notion is that the brain relies on the world and other people as extensions of itself, and we are motivated to behave in ways that help us rely on the world and other people in this way. I want to argue that "you" are not confined to what's in your head, but are in part represented in things around you, including other people. If so, then it makes sense why natural selection operates in part at the level of the group -- so does the individual! Let's see where this takes us.

Shaping the Environment

I will begin with an anecdote, which while not conclusive is at least evocative. Traffic in the Boston area rivals that of Rome; as a pedestrian you take your life in your hands by jaywalking. This is nothing new, of course, and long ago city fathers decided that pedestrians needed an "environmental support" to increase their chances of successfully negotiating traffic when crossing streets. And thus arose (I surmise) the invention of the crosswalk. Crosswalks are a feature of the environment that are designed to help us humans accomplish a task. However, some crosswalks are better than others at fulfilling this role. Specifically, I recently noticed that crosswalks in Cambridge, Massachusetts, were gradually being repainted as “zebra stripes” (horizontal stripes about 18 inches wide and 6 feet long, with each stripe alternating with an equal amount of unpainted pavement). The first time I had seen such crosswalks was on the cover of the Beatles' *Abbey Road* album shortly after it was released. At that time, crosswalks in the U.S. consisted of two long lines that traversed the street, indicating the boundaries of the pedestrian corridor. But now, those European-style crosswalks are commonplace in Cambridge. In fact, they are displacing the old-style ones -- and for good reason: The zebra striped ones are objectively better at doing what crosswalks are supposed to do. From the point of view of the driver, they reflect more light and indicate better the zone where pedestrians may be crossing. From the point of view of the pedestrian, they delimit better the walking corridor.

But more than that, the zebra striped crosswalks are also better for another, deeper reason: they engage brain systems that help one to walk automatically. This is demonstrated by studies of people who have Parkinson’s disease. Such patients often shuffle because they lack sufficient amounts of a key neurotransmitter (dopamine) in the frontal lobes, which are used to direct voluntary movements; however, if these patients are asked to walk over a set of boards placed crosswise at regular intervals in front of them (like railroad ties), they walk smoothly. The visible stimuli engage another part of the brain, the cerebellum, which plays a key role in automatic movements. The stripes on the crosswalk seem to do the same. In fact, if you look at that Abbey Road album cover, you’ll notice that they are walking with wide strides – which seem to be calibrated to the width of the stripes. The crosswalk not only delimits the pedestrian corridor well, but may also engage automatic movements to help walkers to cross more swiftly. It is clear that, given what crosswalks are designed to do, for humans the zebra stripe version is better than the two-lines version.

This example illustrates a broader point I want to make. For many (most?) tasks, we humans do better when the environment is properly engineered. Nobody would argue with this general assertion, but the question immediately arises: What does it mean for the environment to be "properly engineered"? An important aspect of human nature is that we are limited. Humans can only run so fast, jump so far, and can't sprout wings -- if we could run faster, jump 50 feet in a single leap, or fly, we probably wouldn't need crosswalks to help us get across even busy boulevards. We engineer the environment to make up for our limitations. And the most important such limitations, in my view, are in our brains: Our brains can process information only within limited bounds. For example, if speech is sped up faster and faster (in such a way that the pitch is held constant -- no chipmunk voices here), the brain areas that process it work progressively harder and harder. But at some point, the speech becomes incomprehensible – and at just that point the various brain areas stop working so hard (Poldrack et al., 2001). Our brains are limited not only in our abilities to process information, but also in the amount of information we can hold in mind at the same time. For example, if you are asked to multiply 3,976 by 5,222, you probably will find this difficult to do in your head. This observation leads to the central part of my argument, namely that we rely on the world as an extension of ourselves, to make up for our limitations.

Social Prosthetic Systems

There are many obvious and dramatic illustrations of ways that the environment can make up for a deficit. For example, if you were missing a leg, you would receive a substitute -- the modern equivalent of the proverbial wooden leg. This leg is a prosthesis, it fills in for a missing part of your anatomy. This would be true even if you were born without the limbs; a prosthetic can not only replace what we once had, but also can provide essentials that were missing from the outset. But don't think that only the unfortunate rely on prosthetic devices. All of us do, much (perhaps even most) of the time. For example, consider how you would actually go about multiplying those two large numbers, 3,976 by 5,222. Because we humans have a limited working memory capacity (Baddeley, 1986; Smith & Jonides, 1997), and thus cannot hold such numbers in mind and work on them effectively, we rely on external aids, such as pencil-and-paper or a calculator. These socially created aspects of the world are prosthetic devices -- they compensate for a deficit, just as a prosthetic leg would do if a leg had been amputated or you were born without the limb.

But notepads and calculators are not the most powerful or common prosthetic devices we use. More interesting, in my view, is that we rely on other people as extensions of ourselves. Specifically, we rely on other people to extend our cognitive and emotional capacities. Others help us formulate alternatives, evaluate options, and make decisions; others also help us interpret and control our emotions. *Evolution has allowed our brains to be configured during development so that we are "plug compatible" with other humans, so that others can help us extend ourselves.*

When someone devotes time and energy to helping you, you are literally using part of their brain. Your self extends beyond your own head, and into those of others who work with you. Such situations constitute what I call *social prosthetic systems* (SPS). A *SPS is a socially created system that extends one's emotional or cognitive capacities.* The idea of a SPS must be distinguished from the idea of a team, where members work together to achieve a common goal, or of "distributed cognition," where people take on different aspects of a cognitive task in order to improve how well a group performs (e.g., Wegner, 1995; see also Hollingshead, 1998). My idea is different in two ways: First, in a SPS, one person has a goal, and draws other people in as prosthetic supplements to help him or her accomplish that goal. The other people function as extensions of the agenda-setter -- and in fact may or may not desire to accomplish that task for its own sake (we'll get to their motivations shortly). Second, I conceive of a "goal" in the broadest possible way, so broadly that whenever two or more people interact they are attempting to achieve at least one goal; we always have agendas, even if they are as mundane as simply relaxing or wanting emotional support. A SPS can be set up to help you relax, but few of us are lucky enough to have a team devoted to achieving such a goal.

We can distinguish between two types of SPSs. On the one hand, short-term SPSs are set up in a specific context with the aim of accomplishing a specific task. For example, if you are moving a heavy box, a friend might lend you a hand. Or if you are stuck in writing a computer program, a person at the Help Desk might point out your error. These sorts of SPSs are transient; once the task is accomplished, the SPS ceases to exist. On the other hand, long-term SPSs come to be relied upon not just for one specific task, but for a class of tasks. Such SPSs rely on establishing enduring relationships. For example, your spouse can help you handle interpersonal problems at work and help you plan your next vacation together. Such long-term SPSs are like tools in a toolbox. One you have them, they remain available to be used in the appropriate circumstances.

Two Sources of Motivation

What does all of this have to do with human motivation? I want to argue that this perspective provides insight into two sources of motivation. First, we are motivated to create, extend and support specific social prosthetic systems, in part because the "self" becomes distributed over other people who function as our long-term social prosthetic systems. Second, we are motivated to create conditions that will induce others to serve as our SPSs. The following two sections address each type of motivation in turn.

The Self in Social Context

I propose that humans are motivated to establish, extend and deepen long-term SPSs. This makes sense from a strictly functionalist perspective because one will be better able to cope with future events if: a) existing SPSs are further strengthened, making another person more willing or able to help one; or, b) more SPSs are established, with a greater range of skills and abilities to draw on. Return to the toolbox analogy. The better the tools, and the greater number and more varied they are, the better positioned you are for the future.

However, I think there's a deeper reason why we find it so gratifying to establish relationships with others where we can count on their loyalty and assistance in the future. Namely, a result of setting up deeper and/or more and more varied long-term SPSs is that your "self" is more firmly entrenched outside your body. When another person assumes the role of a long-term SPS, he or she has "gotten to know you," and has learned how to behave in ways that help you. What this comes down to is that his or her brain has become configured to operate as an extension of yours! All learning involves changes in the brain, and this particular sort of learning involves changing a brain so that it operates well in conjunction with another brain.

According to this view, then, to the degree that you become imbedded in a network of SPSs, your self is not confined to the neural tissue nestled between your own ears; rather, the "self" extends into other people's brains. This idea is consistent with the fact that people have remarkably few stable traits, such as being very honest or having a strong desire to be neat and orderly; instead, much of the way we behave depends on the context in which we find ourselves (cf. Mischel, 1999). These effects of the environment run deep: In fact, different environments upregulate and downregulate genes in the brain, which produce neurotransmitter and neuromodulators -- thereby greasing the mental wheels for some kinds of processing but not others. Who we are depends on where we are and what we are doing. This makes sense because in different contexts, we draw on different prostheses -- and we are the sum of what we carry with us and what we use externally.

Inducing Others to Serve

A SPS helps one only insofar as other people are willing to "sign on" to serve as SPSs. Why would another person be willing to lend you not just an ear, but part of his or her brain? First, others may serve as a SPS because they share the same immediate goal, in which case they also benefit from accomplishing an immediate task; in addition, they may garner an immediate reward, such as being paid (as occurs for psychotherapists delivering psychotherapy). Second, others may serve as a long-term SPS because they are investing in the future, expecting reciprocal behavior from you. In other words, one reason others may become your SPSs is because they expect that you later will serve as their SPS.

This leads to a final idea: We humans are motivated to improve our skills and abilities because this prepares us better to cope with future challenges. There are obvious evolutionary advantages for having such inclinations. But working to improve oneself leads to a secondary gain: By developing our skills and abilities, we also make ourselves more valuable to others, which in turn leads them to be more willing to serve as our SPSs. If others perceive that we have "something to offer," they will be willing to invest their time and effort for us in hopes that in the future we would be a valuable SPS for them.

Implications of the Theory

Consider some implications of this theory. First, the theory leads us to infer that diversity is not a luxury, but rather is essential in many walks of life. Think about why a carpenter has many different devices in his toolbox. It's impossible to know in advance what challenges the environment will produce, and what abilities will need to be marshaled -- and if you need abilities you don't possess, you'll need to draw on others as prosthetic devices. Variety is more than the spice of life -- it's the essence of life. Hypothetically, I can imagine a stripe of eugenicists who would be inclined to exterminate dark-skinned, hunched, hairy little men -- but if another ice age descended, those people might well have been the very ones best suited to survive. Just as the genes were smart enough to populate the brain with the potential to cope with many eventualities, we should be smart enough to nurture a wide variety of people in our societies, to cope with many eventualities. We cannot know in advance what sorts of SPSs we will need to help us negotiate future challenges.

Second, the theory explains why many people are motivated by a desire "to make a difference." To the extent that your views change how others think, feel and behave, they can function as SPSs for you. And to the extent that others are "configured" to be receptive to being your SPS, you have created an environment in which you can recruit more ways to distribute yourself. And the more distributed you are, the more likely you are to survive. This notion might also explain why fundamentalists of all stripes proselytize so vigorously, and why many of us try so hard to convince others of our most deeply held views.

To return to the issue I broached at the outset, why did the terrorists willingly kill themselves? According to this theory, each of them was a member of a set of SPSs that are embedded in a particular culture, and thus their identity was distributed over many other people. And because the "self" is distributed over those who serve as prostheses, to the extent that they felt tightly embedded in this group -- which they perceived to be their culture at large -- they would perceive that essential components of their selves would continue to exist even when their bodies died. Thus, they sacrificed their bodies to preserve their "greater selves." The same reasoning would explain why a soldier would willingly throw himself on a grenade to save the lives of his comrades-in-arms. Objectively, these behaviors may be misguided because no matter how distributed one's self becomes, there's still more of it embedded in one's own brain; but nevertheless, if one perceives that one's identity is distributed over the group, one will not perceive one's death as obliterating the self -- and to some extent, this perception is not erroneous.

Consider another example: Why would someone help an old lady cross the street, even if she never mentioned it and nobody else observed this generous act? If one feels virtuous, this feeling alone may increase one's sense of self-worth. And feeling more valuable, one will feel better able to induce others to serve as SPSs. The same line of reasoning allows me to explain why some people are motivated to perform an act of vengeance (such as the man who kills his wife's murderer): If one views this act as enforcing the social order, one will feel that one has increased one's value to other members of the society. However, precisely the same motivation could lead others *not* to perform an act of vengeance -- it all depends on how one perceives the consequences of one's act.

Such reasoning can be used to explain why people are motivated to perform any behavior that increases their competence (I don't mean "competence" in the linguistic sense, which is distinguished from performance, but rather in the sense of increasing one's skills and abilities). For example, consider an amateur artist who takes great pride in her paintings. She might be highly motivated to learn to paint the sky well, even if this act would be considered rather minor in the greater scheme of things. Why is she so motivated? To the extent that we develop competence, we make ourselves valuable as SPSs to others -- and that in turn means that others will be more willing to allow themselves to be relied upon as our SPSs. Although you and I might not consider learning to paint a valuable skill, someone who wants a portrait of their children or a painting of a favorite vista might. Moreover, because it is impossible to know which particular competences will be valued most in the future, we are motivated by our own perceptions of value.

This perspective leads me to reconsider Hamilton's (1964) notion of inclusive fitness. In my view, behaving altruistically to those with shared genes may account for behavior of lower animals, and may have been the origins of some forms of human behavior. But after humans developed their current range of cognitive and emotional competences, selection may have focused on something else: the ability to interact with others so that they function as SPSs. For humans, the number of shared genes may be less important than the likelihood that the others can function as your SPSs. Specifically, those who share our temperaments (which apparently are in part under genetic control; Kagan et al., 1994), and who live in close proximity, are good candidates to be long-term SPSs. Here's a thought experiment: Say you had an identical twin who was separated from you at birth, whisked off to Afghanistan and raised as an especially fanatical member of the Taliban. Now say that at age 35, you meet your sibling for the first time, and are forced to choose between the life of your spouse -- who shares zero of your genes -- and your identical twin. Which will it be? In my own case, my strong intuition is that in that situation I would choose my SPS over the stranger who happens to share all of my genes. In fact, I would make this decision in a flash, with no conflict or anguish. One might object that my spouse is valuable because she has the potential to have children, and thus perpetuate my genes. To counter this possibility, imagine that your spouse is sterile or your children are grown. Would that change the equation? I would make the same prediction for homosexual couples who have established a long-term relationship, even though there is no issue of a confound with genetics.

Conclusion

This chapter has developed an argument with the following structure: 1) evolution shaped our brains to "assume" that they would exist in particular kinds of environments; 2) the environment, particularly the social environment, sculpts the child's brain so it can work well in that environment; 3) as adults, we use the environment as a crutch, to help us accomplish tasks; 4) a critical way in which we use the environment is by relying on other people to extend our skills and abilities, creating social prosthetic systems (SPSs); 5) we can distinguish between two kinds of SPSs: short-term and long-term; 6) humans are motivated to behave in ways that create, extend and support long-term social prosthetic systems in part because the "self" becomes distributed over other people who function as long-term social prosthetic systems; 7) finally, people are motivated to increase their skills and abilities in part because it makes them more valuable as potential SPSs, which in turn provides motivation for others to serve as their SPSs.

At the most general level, I suggest that motivation can be divided into two very general categories. The first concerns behaviors that either allow one to gain sensory rewards or to avoid unpleasant states; we do things because they feel good or they have consequences that feel good, or because they help us avoid things that feel bad or have consequences that feel bad. I include all of the basic biological drives in this category (such as eating and sex), as well as activities driven by aesthetics (such as listening to music). The second class concerns behaviors that develop competences. I divide this class into two parts, those behaviors that enhance skills and abilities that can be directly applied in the world (such as learning carpentry or money management), and those behaviors that develop competences that function primarily to create, extend and support SPSs or that will increase one's probability of recruiting SPSs. This last category of motivations may be uniquely human.

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FOOTNOTE ADDED AFTER PUBLICATION. This chapter was published without the copy-edited manuscript or ther page proofs' being sent to the author. The present version contains all corrections that should have been included in the published article. In addition, I had intended to add a footnote acknowledging that Andy Clark and David Chalmers had independently devised a similar idea of "cognitive prostheses," but applied only to objects (not to other people). I was not aware of this work until after the manuscript of this paper, written in 2001, had been circulated. I am grateful to Terry Dartnall for bringing Clark and Chalmers's important work to my attention, and regret that I did not have the opportunity to integrate it into the present proposals.

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