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LESSONS FROM NEUROSCIENCE AND EXPERIMENTAL PSYCHOLOGY FOR A PARTNERSHIP SOCIETY

Daniel S. Levine, PhD

Abstract

This century has seen explosive growth in our knowledge about the human brain and mind due to recent advances in neuroscience, experimental psychology, and neural network modeling, and convergence between those fields. The scientific findings that have emerged confirm that humans have evolved for partnership and cooperation at least as much as they have evolved for domination and competition. Moreover, the findings suggest that partnership interactions promote optimal brain functioning.

Keywords: partnership, brain, neuroscience, psychology, neural networks, decision

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THE PROBLEM AND ITS BACKGROUND

Many of us involved in the cultural revolution of the 1960s and 1970s hoped that the trends of that period heralded a new age in human relations and mutual compassion. We kept saying that technology was already way ahead of our understanding of each other and that we needed advances in human relations to catch up to technological advances. We believed that our advocacy of making love not war, and of more open roles for people regardless of gender and race, would be the first steps toward making that happen.

Yet that period of promise ended up with the most visible representatives of the changing times being, not social reformers, but Silicon Valley technological entrepreneurs such as Steve Jobs (Isaacson, 2011). The Internet, smart phones, and other devices and apps have provided great benefits for communication of like-minded

people across long distances, even enabling the publication of partnership-oriented journals like this one. Yet many of the short-term effects of rapid technological growth on society have been less than beneficial: rising inequality of income, loss of stable employment for many, and a harried pace of life even for economically successful people trying to keep up with the changes. Thus overall the growth of thoughtful human relations has lagged ever further behind the growth of technology.

Paradoxically, while the growth of technology is the fruit of scientific advances, it has not increased scientific literacy among people as a whole. As the journalist John Saul described a generation ago (Saul, 1992), scientific and technological advances have instead spawned a cult of the expert, whereby average people make use of the new devices but treat them as magic whose workings only the savvy can understand. Recent changes since Saul wrote have if anything accelerated this trend. There is widespread ignorance, some of it willful, not only about technology but also about basic science. In the United States, Achenbach (2015) documents widespread distrust of pronouncements of scientists on everything from evolution to climate change to vaccines: “A THIRD (emphasis Achenbach’s) of Americans believe humans have existed in their present form since time began” (p. 41) and “LESS THAN HALF (emphasis Achenbach’s) of all Americans believe the Earth is warming because humans are burning fossil fuels” (p. 45).

Yet (invoking another catch phrase of the 1960s and 1970s) science can become part of the solution instead of part of the problem. As a graduate student in mathematics during that period I struggled to make my own field and my training “relevant” to positive social change. My opportunity came when the military draft during the Vietnam War caused me to leave school for a research position at the National Institutes of Health (NIH). My stay at NIH exposed me to leading neuroscientists who were involved in dialogues about the role of the brain in evolution and the relationships between instinct, emotion, and thought. Here, I thought, neuroscience could yield clues to understanding, and hopefully influencing, human decisions that affect social policies, including the Vietnam War itself. And my mathematical training could help with

developing computational theories that might tie together enormous amounts of data from neuroscience (both animal and human) and experimental psychology. That was the beginning of my long career as a computational neural network theorist.

The research of several pioneers in neural networks began in the 1960s before there were widespread personal computers and ability to transfer files electronically. It also began before the wide availability of functional magnetic resonance imaging and other tools for non-invasively recording the activity of human brain regions during the performance of cognitive and behavioral tasks. So it took many decades for the brain to be well enough understood that the findings of neuroscience could be useful in promoting broad understanding of human social behavior. But in the 21ST Century enough results in cognitive and behavioral neuroscience have emerged that the field can start to inform social policies. Insight from neuroscience can also inform discussions of cultural mores that might encourage or discourage partnership interactions.

In this period in which the world is rapidly growing more complex, it is tempting to feel that promoting partnership is simply a matter of defending previously established democratic, cooperative, and egalitarian values. Yet to advance the cause of partnership in these challenging times we must not only play defense but go on the offense, designing social policies and trying to influence the development of cultural customs that bring out the best in human potential in the information age.

Going on the offense means that cherished mindsets need to be examined and changed, a process that is likely to be painful but ultimately rewarding. Cultural assumptions about many common things – including the role of technology, traits we attribute to groups of people (e.g., genders or ethnic groups), how we categorize, how we look at reason and emotion, and how we look at the individual and society – need to be challenged, as many are unsuited to the complexities of the current times (Clark, 1995; Eisler, 1995; Levine, 1998a).

I will now review some of the intellectual roots of our current challenge – in particular, the roles of neuroscience, experimental psychology, and neural network theory in understanding the bases of partnership interactions.

INTELLECTUAL ROOTS

Neuroscience

Until the 1960s most neuroscientists believed that the human brain's connection patterns, and therefore its capabilities, were fixed at birth. Psychologists such as Sigmund Freud (1895/1966) and Donald Hebb (1949) believed there must be some change going on in the brain when people and animals learn a new association, such as in conditioning. Freud and Hebb both conjectured the existence of plasticity at synapses between neurons; that is, they believed that some connections would become more likely to transmit electrical impulses if the concepts coded by the two neurons they linked were repeatedly presented together. Yet such plasticity was not observed in neuroscience laboratories until the work of Nobel laureate Eric Kandel (e.g., Kandel & Tauc, 1965) who discovered in the California sea slug (*Aplysia*) a mechanism called *heterosynaptic facilitation*, a change in synaptic efficacy (or cellular excitability) in one neuron as a result of release of a modulatory transmitter from another neuron.

In mammal brains, the first significant observation of plasticity was made by Timothy Bliss and Terje Lømo (1973), who demonstrated in the rabbit hippocampus - a key region for laying down traces of new memories – a phenomenon they called *long-term potentiation* (LTP). Bliss and Lømo defined LTP as a persistent enhancement of synaptic efficacy generally produced as a result of delivering a brief (several second) high-frequency train of electrical stimuli to an incoming pathway. In other words, an existing synapse becomes strengthened, in the sense that an electrical impulse to the incoming pathway becomes more likely to cause electrical activity in the neuron to which it connects. This increase in synaptic strength can last up to several hours in an interconnected group of isolated neurons grown in the laboratory, and up to several days in a living animal.

Other scientists showed that LTP can be enhanced while the animal is learning associations between concepts. Many scientists now believe that the cellular changes related to LTP make the hippocampus uniquely suitable for its job of encoding learned associations between concepts and laying down memory traces.

The brain is most plastic during childhood but still remains subject to change in adulthood, to varying degrees along different pathways (Begley, 2007; Byrne, Heidelberger, & Waxham, 2014). Because of this childhood plasticity, the brain's connections as an adult are highly influenced by early experience. This was first discovered in the 1960s and 1970s with sensory systems, to the surprise of neuroscientists. For example, Hirsch and Spinelli (1970) found that kittens who were raised in environments without visual inputs of specific line orientations (such as vertical or horizontal) grew up to be adult cats that were blind to those orientations. The partial blindness occurred because cells in the cats' visual cortex that normally would respond to lines they had not seen were re-coded to lines the cats had seen.

Since the early 1990s a host of animal and human studies have found major lasting effects of early experience on areas of the brain involved in both cognitive and emotional functions. These areas include the hippocampus, where short-term memories are consolidated in long-term memory; the amygdala, main site of emotional evaluations; and the frontal lobes, a key area for planning, decision making, and moral judgment. In particular, these regions function differently in individuals who were abused or neglected as children than in individuals raised in caring environments. That literature is summarized in several other articles (e.g., Eisler, 2014; Eisler & Levine, 2002; Levine, 2008) and partially reviewed here.

One of the first scientists to study the effects of childhood abuse on the adult brain was Bruce Perry (e.g., Perry, Pollard, Blakley, Baker, & Vigilante, 1995; Perry, 2002). Perry and his colleagues found that in children who are repeatedly physically or sexually abused, the biochemical system that gets active in response to stress becomes chronically sensitized. This system, which includes parts of the brain, endocrine glands,

and connections to other organs, is called the *hypothalamic-pituitary axis (HPA)*. HPA activity particularly involves two biochemical substances: norepinephrine, the neural transmitter closely related to arousal, and cortisol, the hormone related to stress. In individuals whose lives are not overly stressed, the level of cortisol goes back down after the danger has passed. Yet in chronically abused individuals, this level remains permanently high. This means the person is more likely to have an arousal response to stimuli that are milder than the initial traumatic events. Norepinephrine tends to remain higher than normal in some individuals who react to abuse by a chronic fight-or-flight mode, but is lower than normal in others who react to abuse by becoming dissociated. Perry et al. (1995) found that the fight-or-flight pattern is more common in males, and the dissociative pattern is more common in females.

Since 1995 there have been a number of studies of the cortisol and norepinephrine systems in people subject to chronic stress, including social exclusion as well as violence and poverty (e.g., Gunnar and Herrera, 2013; Knack, Jensen-Campbell, & Baum, 2011; Miller, Chen, & Zhou, 2007). Cortisol levels are sometimes unusually high in chronically stressed individuals and sometimes unusually low, but generally are abnormal in some way. Typically, in chronically stressed people the cortisol level remains constant rather than going up or down with either the time of day or the presence or absence of stressors.

The abnormalities in chronically stressed individuals are not only in emotional reactivity but also in cognitive function. Sustained stress particularly has negative effects on the function of the hippocampus, the area of brain that plays an essential role in consolidation of new memories and acquisition of information. Sapolsky (2003) reviewed evidence that cortisol and various forms of stress (including physical restraint) reduce neural plasticity in the hippocampus in both rodents and primates. At the same time, cortisol and stress increase plasticity in the amygdala, the major site of emotional memories, and thereby enhance conditioned fears including negative emotional reactions to places and other stimuli associated with stressful events. Sapolsky notes that mild stress can be experienced as a challenge and thus can enhance cognitive

performance; this author outlines the differences between two different types of cortisol receptors in the brain that mediate the helpful versus the harmful effects of stress. A more recent human brain imaging study found that a higher degree of maternal or caregiver nurturance (demonstrated by the strategies caregivers used to regulate a child's impulse to open a gift for which they are asked to wait) is positively correlated with a larger volume of the child's hippocampus when the child reaches school age (Luby et al., 2012).

There are also neural systems that become more active with positive social interactions: these particularly involve two related peptide hormones, oxytocin and vasopressin. Social psychologist Shelley Taylor and colleagues (Taylor et al., 2000) described what they called the *tend-and-befriend* response that women and female animals often employ as a response to stress, in preference to the traditionally studied fight-or-flight response. The tend-and-befriend response, mediated by the brain's oxytocin system, includes both tending of offspring and social bonding between females (mutual grooming for nonhuman animals, friendship for humans) around mutual protection of selves and offspring. Other results to be cited hint that these mechanisms exist in male animals as well, despite gender differences in amounts of some biochemical substances involved.

The hormone oxytocin, found only in mammals, was first discovered to be essential for maternal physiologic functions such as uterine contraction and milk ejection. But Thomas Insel, James Winslow, and their colleagues discovered that oxytocin has broader importance for bonding, in male as well as female animals (Insel, 1992; Insel & Winslow, 1998; Winslow, Shapiro, Carter, & Insel, 1993). Insel and Winslow studied two species of North American rodents that are closely related but have radically different social organizations: the prairie vole, which is monogamous, with strong male-female pair bonding and both parents involved in care of young, and the montane vole, which is promiscuous, with fathers uninvolved with young. They found that oxytocin attaches to receptor molecules in reward-related areas of the brain in the pair-bonding prairie vole but not in the non-bonding montane vole. Analogous results were seen in a

comparison between two closely related species of monkeys. Rosenblum et al. (2002) found that bonnet macaques, who tend to be gregarious, affiliative, and emotionally stable, have higher levels of oxytocin and lower levels of a substance involved in production of the stress hormone cortisol in their cerebrospinal fluid than pigtail macaques, who tend to be emotionally volatile and socially distant.

In humans, Kosfeld et al. (2005) found that intranasal administration of oxytocin to men playing a simulated investment game increased their ability to trust their partners. Results of a more recent study by DeDreu, Greer, Van Kleef, Shalvi, and Handgraaf (2011), however, suggest that the trust could be selective rather than universal. Specifically, Dutch subjects showed increased trust of other native Dutch people but not of immigrant Muslims. That result is unsettling for those interested in the biological roots of partnership interactions, but it is consistent with the selectivity of pair bonding (and of friendship, where oxytocin may also be involved). Perhaps an ability to empathize with people who are very different from us requires not only oxytocin binding to emotional reward areas but also the cognitive element of seeing people of a different nationality or ethnicity as analogous to us. This cognitive aspect of empathy is likely to require the activity of regions of the prefrontal cortex which process emotional and social information.

Uvnäs-Moberg (1998) reviewed evidence that oxytocin administration in both male and female rats appears to counteract many of the typical physiological and behavioral effects of stress. For example, oxytocin administration is related to decreases in blood pressure and in levels of cortisol. More generally, oxytocin administration reduces activity in the sympathetic part of the autonomic nervous system, the part that is activated in the fight-or-flight response. Uvnäs-Moberg (1998) reviewed studies showing that the physiological anti-stress effects of oxytocin occur in association with both lactation and sexual intercourse, and conjectured that oxytocin is also released by other forms of pleasurable social contact such as mutual grooming in animals and supportive friendship in humans. Heinrichs, Baumgartner, Kirschbaum, and Ehlert (2003) found evidence for oxytocin's role in positive social contact. These researchers

gave adult men stressful tasks (public speaking and mental arithmetic); before the test the participants were either given intranasal oxytocin, asked to bring their best friend for social support, both, or neither. Both oxytocin and social support substantially reduced the amount of cortisol induced by the tasks, and oxytocin enhanced the anti-stress effect of social support.

When people in universities and granting agencies speak about the social benefits of increasing our understanding of the brain, they speak primarily of the role of neuroscience in helping to treat neurological and mental disorders. In fact, the opening statement of the United States' current brain research initiative (<https://www.whitehouse.gov/share/brain-initiative>) is: "President Obama is making new investments in the 'BRAIN' Initiative — a bold new research effort to revolutionize our understanding of the human mind and uncover new ways to treat, prevent, and cure brain disorders like Alzheimer's, schizophrenia, autism, epilepsy, and traumatic brain injury." More recently, there has also been wide interest in what neuroscience tells us about how people learn, which has inspired the development of "brain exercising" software such as Lumosity, and efforts by school systems to introduce more "brain-friendly" curricula.

All of these applications are vitally needed and welcome. Yet there has been less interest in the equally important issue of what neuroscience tells us about how to structure society, both at the formal level of social and economic policies and the informal level of social customs and mores. Now we have enough emergent knowledge about the brain that we can make arguments based on neuroscience for the beneficial effects of partnership interactions and the harmful effects of dominator interactions on society as a whole, as well as on each of its members.

Decision psychology

Before the late 1960s, the study of human decision making was dominated by a theory, derived from economics, which assumed people were rational, self-interested actors. In this outlook, an individual's preferences were stable, quantifiable, and consistent,

and obeyed certain straightforward mathematical rules. That outlook was challenged by the findings of several psychologists, most notably Daniel Kahneman (who subsequently won the economics Nobel Prize in 2002) and Amos Tversky (who probably would have shared that prize had he been alive then). Kahneman and Tversky found that people's preferences between two alternatives were often inconsistent across different ways in which the alternatives were framed (e.g., Tversky & Kahneman, 1981). Moreover, they found that both preferences and numerical judgments were often biased by rules of thumb (heuristics) that arose naturally from experience but lacked logical foundation (e.g., Tversky & Kahneman, 1974).

Tversky and Kahneman's results were sometimes interpreted as pointing to the "dark side" of human nature - that is, to the inability of sweet reason to control our irrational natures. Indeed, the heuristics and framing effects they describe do sometimes lead to calculation errors as well as sub-optimal choices. Yet I will argue here that Tversky and Kahneman's theory of human decision making is much more consistent with a partnership outlook than is the rational choice theory that it displaced. Our heuristics and framing effects are behavioral outgrowths of the neural plasticity discussed in the previous section of this paper. Hence the results of decision psychology experiments suggest that if people are currently making choices that are harmful to society or to themselves, those choices do not necessarily represent their real or permanent preferences. This means that a different set of events could lead the same person to make more constructive choices on another occasion.

Cognitive psychologists Valerie Reyna and Charles Brainerd trace human reliance on heuristics to our capacity for mentally simplifying and selecting from the information we receive rather than processing every detail of the information. In a long series of articles (e.g., Brainerd & Reyna, 1990; Reyna, Lloyd, & Brainerd, 2003; Reyna, 2012) these researchers develop a theory of both memory and decision making which they call *fuzzy trace theory*. Fuzzy trace theory posits the coexistence and interaction of two distinct systems for encoding information: literal or *verbatim* encoding, and

intuitive or *gist* encoding. Verbatim encoding means literal storage of facts, whereas gist encoding means storing the essential intuitive meaning or “gist” of a situation.

The results of Reyna, Brainerd, and their colleagues suggest that as we grow into adulthood we gradually rely more on gist processing than we did as children, and less on verbatim processing. This development is partly due to the accumulation of life experience and partly to an increase in time pressure. Reyna and Brainerd argue that gist processing, despite being less precise, is actually a more advanced form of thinking than verbatim processing. I agree partially, but also believe that it is important to consider *what* gists we encode - that is, which attributes of information we select for greater attention. Gist processing can lead us to focus on those aspects of the information we receive that are most relevant to our tasks. But gist processing can also lead us to focus on aspects that are irrelevant but feed previously established emotional prejudices, such as dealing with people on the basis of superficial attributes like skin color or facial expression.

At the same time, knowing that adults use gist encoding can help us understand each other better. Specifically, the awareness of gist processing can make us more thoughtful and compassionate in our attributions of other people’s behavior. The attribute of another’s behavior that is most salient to us, whether positive or negative, may not be the attribute that is the primary motivator for that person. Applying this principle can help all of us to curb our initial reactions when they are likely to lead to prejudices or destructive confrontations. For example, a poor person who chooses public assistance over a low-paying dead-end job may not be irresponsible or lazy, but may just be choosing the best alternative in a bad situation.¹ And a person taking out a high-interest payday loan may not be improvident for the future, but may simply doing what is needed to handle a present emergency.

¹ This is not to mention the growing number of poorly paid workers living in expensive areas who require public assistance IN ADDITION TO a full-time job salary!

While the rational self-interest model is still prevalent in economics, there is an increasingly influential school of *behavioral economists* who are recognizing that individual choices are not based on fixed preferences but are malleable by circumstances (see, e.g., Thaler, 2015). Consequently, it is incumbent on those who have the power to shape circumstances, whether in government, businesses, schools, or anywhere else, to try to make changes that can help people make decisions that are constructive both for themselves and for society.

The application of psychological decision data to shaping personal choices is discussed by behavioral economist Richard Thaler and legal scholar Cass Sunstein in a book called *Nudge* (Thaler & Sunstein, 2009). Laissez-faire economists and other libertarians believe that a free market will automatically make people decide to do the things that most benefit themselves, including decisions that are beneficial to society (such as conserving energy) if those things are important to the deciders. But Thaler and Sunstein argue that beneficial choices are not automatic, particularly choices that people make infrequently (such as buying cars or houses) or do not get immediate feedback about (such as helping or harming the environment). These authors give many examples in many domains of “choice architecture” that, without imposing mandates, can shape people’s decisions by giving them incentives “nudges”) to do things that are beneficial. One of the simplest examples concerns placing of foods in cafeterias: it has been shown that when fresh fruits, vegetables, and other healthy foods are placed in easily accessible locations, and candy, potato chips, and other less healthy foods in less accessible locations, both children and adults tend to make healthier food choices (Meiselman, Hedderley, Staddon, Pierson, & Symonds, 1994; Wansink & Deshpande, 1994).

The success of nudges gives support to arguments that people should not be blamed for their unfavorable circumstances, even if their own decisions sometimes perpetuate their conditions. A further argument along these lines comes from the work of behavioral economist Sendil Mullainathan and psychologist Eldar Shafir (Mullainathan & Shafir, 2013). These researchers show that scarcity of any resource, such as money,

time, or social contacts, changes people's decision making. Under scarcity, their attention becomes more focused on immediate use of the scarce resource, to the neglect of other factors that could be important in the long term. This, rather than personality tendencies of the poor (a "culture of poverty"), explains some behavior of poor people such as borrowing money at very high interest rates; as Shah, Mullainathan, and Shafir (2012) put it, "Scarcity, of any kind, will create a tendency to borrow, with insufficient attention to whether the benefits outweigh the costs" (p. 683). These researchers applied the same principle to other types of scarcity, such as scarcity of time for very busy people.

Bertrand, Mullainathan, and Shafir (2006) applied the theory of decision making under scarcity to explanations of other financial decisions by the poor, such as not setting up bank accounts (therefore becoming more vulnerable to predatory lenders) and underutilizing government assistance programs. Their summary of their own data and others' leads them to the conclusion that most poor people are open to making financial decisions that will benefit them more in the long run if the incentives for those decisions are stated clearly and honestly, if they are counseled by friendly and not overburdened advisors, and (contrary to mainstream economic theory) if they are not given too many alternative programs to choose from, in order to reduce cognitive overload.

Demonization of the more disadvantaged members of society, and of those who are conscientiously working to help the disadvantaged, is not confined to welfare programs. It also occurs in the realm of public education. Many efforts at "school reform" in the United States during the current century have included sanctions for "underperforming schools" (which just happen to serve heavily low-income and minority students) and have suggested that ineffective teachers are a main cause of these students' underperformance. Some studies of standardized tests given over several years to New York City area grade school students with a range of family incomes, suggest that blaming public schools and teachers is wrong (Gladwell, 2008). The results of these studies show that the gap in school performance between low- and high-income children does not widen, or even narrows, during the school year. But immediately after each

summer the gap widens in favor of the high-income children. Gladwell's explanation is that high-income children have more opportunities to continue learning over the summer, such as summer school, special classes, and camps with educational programs.

In short, the portrait of human decision makers that has emerged from the cognitive psychology of the last fifty years is of complex individuals whose preferences violate any strict logical rules of consistency. This means that each of us can make either beneficial or harmful choices, and can be induced to make either by interpersonal and societal circumstances. While this view of human nature is troubling at times, it is consistent with arguments for a partnership society because it suggests that societal incentives can shape individual behavior. On the other hand, the rational choice theory favored by economists (sometimes called "rational man" theory, with all those words' sexist connotations) is more consistent with the libertarian outlook of authors such as Ayn Rand (Rand, 1957). Libertarianism seems to assume that everyone does what he or she "wants" to do, which implies that some people deserve better lives than others because they choose to be more productive and industrious. Experimental psychology and neuroscience, by contrast, support a belief in "the inherent worth and dignity of every person" (Our Unitarian Universalist Principles, n.d.), which promotes active struggle to improve the welfare of all.

The same principle applies to our attributions for people's choices of political or religious affiliation, choices that support either partnership or dominator interactions. Rabbi Michael Lerner, in his book *The Left Hand of God* (2006), argues that many people who gravitate to the religious and/or political right do not have indelible "authoritarian personalities" but rather are motivated by a yearning for meaning in their lives. They wish to be valued for their selves and not only for their money-making potential or ability to meet someone else's needs, and do not feel that the partnership-oriented liberals they have encountered value them in that way. The inconsistency of decision preferences argues that the type of people Lerner discusses are open to "nudges" that can move them in a partnership direction. Liberals, he suggests, can provide those

nudges by avoiding labels for their political opponents and showing concern for the issue of meaning.

Computational neural networks

As the relationship between brain and behavior has become better understood, it is natural that this development has been accompanied by a growth in mathematical and computational models (see Levine, 2000, for review). Modeling has helped build unified theories out of heterogeneous experimental data from multiple sources. The sources of the data include electrical recordings from single neurons in the brains of behaving animals; functional magnetic resonance imaging (fMRI) in humans that shows which brain areas are active while they are engaged in tasks; electroencephalographic (EEG) recording of large regions of the human brain; studies of animals with injury to particular brain regions; clinical studies of patients with specific brain damage or specific psychiatric disorders; and behavioral studies of cognitive functions such as perception, attention, memory encoding, language, decision making, and planning.

One of the pioneers of neural network modeling, Stephen Grossberg, stated that the brain's function is to "autonomously adapt to a changing world" (Grossberg, 2006). Often this means that the brain must resolve paradoxes between two or more complementary requirements that are in seeming opposition (Grossberg, 2000). His examples of complementary brain processes included learning about new events while retaining old memories; processing both the cognitive and the motivational significance of incoming stimuli; and seeing both boundaries and surfaces of visual objects. Levine (2006a) gave some other examples of complementary brain processes within the domain of emotions. These included processing expected events versus processing unexpected events; long-term emotional evaluation versus short-term emotional reaction; optimizing the results of one's action versus exploring potential new alternatives; personal stability versus personal growth; and self-directedness versus cooperativeness.

Mathematics is a powerful tool for making sense of a confusing set of influences and for overcoming conventional wisdom to get to the truth. This is particularly true of the

branch of mathematics called *dynamical systems*, defined broadly as the study of how sets of interacting variable quantities change over time (Abraham, Abraham, & Shaw, 1990). Dynamical systems theory was first introduced in the late 19th Century by the great French mathematician Henri Poincaré to develop theories in the physical sciences, then gradually spread into the biological and social sciences as the variables in those fields became better understood. As Loye and Eisler (1987) pointed out, dynamical system approaches to the social sciences help to illuminate how a complex social system can make radical changes in direction, such as between partnership and dominator tendencies, in response to relatively small outside perturbing forces. Because complex dynamical systems are *nonlinear*, that is, do not respond to outside influences in a strict proportional manner, they can have multiple equilibrium states, and pushing the system away from one of the equilibria can sometimes lead them toward a different equilibrium.

The study of dynamical systems in computational neural networks representing individual brains is well developed (Levine, 2000). These networks have modeled processes such as conditioning, working memory, vision, motor control, and decision making. One of the challenges for the future will be to fit models of the individual brain into larger models representing social systems, up to the social system of the entire world. A few computational models have emerged of interactions among multiple intelligent agents (see, e.g., Sun, 2006) but none yet with the predictive capacity that models of individual brains are starting to reach. Extension of some current neural network models to multi-person interactions is likely to generate the type of breakthroughs in the social sciences that Loye and Eisler (1987) proposed.

Conclusion: Environment and genetics both matter

The consensus among both behavioral biologists and science writers is that virtually all human behavioral tendencies are influenced by both environment and genes (Ridley, 2003; Shermer, 2004). The old, unproductive “nature versus nurture” controversy was for many years a distraction from effective inquiry about the interplay of these factors. Ignoring nurture led to the conclusion, shown false by behavioral decision data, that

people's preferences are independent of context. On the other hand, ignoring nature led to a neglect of genuine individual differences. All three of the scientific fields discussed in this section - neuroscience, experimental psychology, and neural network theory - have largely abandoned this useless dichotomy in favor of an integrated inquiry into how environments selectively bring out our tendencies - that is, into "nature via nurture" (Ridley, 2003).

Moreover, scientific results argue that even those individuals who are genetically most oriented toward a dominator outlook are subject to environmental influences in a partnership direction. For example, Gariépy, Gendreau, Cairns, and Lewis (1998) and Gariépy and Rodriguiz (2002) bred some mice to be highly aggressive, and then reared them in isolation, which tends to enhance aggressiveness, up to puberty (about 45 days old). Then at 45 days these researchers brought the high-aggression mice out of isolation and placed them in groups. In their groups, many of those mice became less aggressive and more cooperative.

IMPLICATIONS FOR SOCIAL INTERACTIONS

The studies of stress hormones and oxytocin discussed in the previous section suggest that there should be profound differences between the brains of those living in a dominator-oriented and those living in a partnership-oriented society. There have not been many studies that compared brain function and structure across different societies. Yet the results discussed in the previous section argue for the fruitfulness of studying differences in brain processes between people in societies identified as relatively nurturing and egalitarian and people of comparable age, gender, income, and occupational level in societies that are more authoritarian. Such studies will require a wide range of techniques including fMRI to measure activities of brain regions and other methods for measuring (variable) functional connectivities between brain regions.

The data on maternal nurturance and the brain (Luby et al., 2012) suggest the question: What is the societal analog of a more or a less nurturing parent?² The psychologist Shelley Taylor (Taylor, 2002) asked essentially that question in the last chapter of her book, *The Tending Instinct*. Taylor concluded that one aspect of societal nurturing is the relative fluidity of social hierarchies, which includes relatively small income gaps. She cited statistics showing that life expectancies are longer in societies with smaller income gaps. For example, at the time she wrote, Cuba had a longer life expectancy than Iraq which had about the same per capita income but larger gaps, and Costa Rica which had narrow income gaps had a longer life expectancy than the United States despite a smaller per capita income. Other aspects that Taylor saw as key to a “tending society” included a strong influence of women in the business and political worlds; extensive and reliable social services including health plans; positive valuing of helping professions, both economically and in terms of social status; and availability of mentoring in job situations.

Levine (2009) further explored the optimal organization of society by comparing three democratically organized utopian societies from 1960s and 1970s fiction (Callenbach, 1975: Huxley, 1962; Piercy, 1976) with real modern societies. He argued that these fictional societies had several features in common that were different from most of the modern world, and that those features promoted optimal brain functioning. The “three pillars” of utopian societies were increased trust, community without conformity, and orientation toward delight. Levine (2009) found that the features that supported those pillars included

... child-rearing based on promoting independence; family units that are larger or more fluid than current nuclear families; increased openness of emotional expression; conflict resolution that emphasizes mediation; gender equality, and strong roles for women; and democracy of creativity (artistic production is

² The linguist George Lakoff (Lakoff, 2014) uses the terms “nurturing parent” and “stern father” for partnership and dominator outlooks respectively.

spread across many people, talented artists and intellectuals also do manual work, and creativity is encouraged in mundane jobs). (p. 258)

Why is each of these “utopian” features good for brain functioning? As for independence-oriented child-rearing, Levine (2009) noted that the prefrontal cortex, the part of the brain most involved in planning and in the moral sense, is developing all through adolescence (Thompson et al., 2000). The results on stress and early influences suggest that frontal development is likely to be best promoted by nurturance and encouragement rather than hierarchical control. Fluid families mean that children are exposed to multiple adult influences. Cognitive psychologists have found that learning of both verbal and motor skills is enhanced by their being taught in multiple contexts (Schmidt & Bjork, 1992), and the same is likely to be true for moral and decision-making skills. Emotional openness is likely to be beneficial for decision making because of the strong connections between the brain’s cognitive and emotional processes that are essential for planned behavior (Damasio, 1994).

Moreover, honest assessment rather than concealment of the emotional impacts of decisions on people leads to more accurate assessment of the ultimate consequences of those decisions. An emphasis on mediation rather than winning or losing in conflict resolution, Levine argued, is likely to reduce the negative effects of excessive cortisol and promote positive affect which is beneficial for creativity. This process may involve dopamine transmission in the brain (Ashby, Turken, & Isen, 1999). Strong female influences increase the likelihood of tend-and-befriend responses to conflicts. In general, tend-and-befriend is most beneficial for problem solving except in the most dangerous situations which may require fight-or-flight responses (Taylor et al., 2000).

The arguments for democracy of creativity are not yet as well supported as the others by neuroscience data, because they are on the social rather than the individual level. Yet there are behavioral studies that show the benefits for problem solving of encouraging creativity (Rietzschel, Nijstad, & Stroebe, 2007). These results suggests

that society functions better if it promotes creativity on the part of all people involved in a process, from CEOs and presidents to clerks and waiters.

This article calls for more openness and more democracy in our social institutions, which sounds like a no-brainer (no pun intended). But people in responsible leadership positions in any institution, no matter how well-intentioned they may be, often carry over unconscious habits of thinking from dominator interactions which have been prevalent for so long. Therefore it takes a conscious struggle to start new ways of thinking and acting in any aspect of life, whether religion, politics, psychotherapy, family life, education, or science, for example. My book *Explorations in Common Sense and Common Nonsense* (1998a, particularly Chaps. 9 and 12) explores partnership-oriented approaches to different segments of life, informed by human psychology and neuroscience. A few of these approaches are summarized next.

Religion

A partnership approach to religion falls between, and bridges, the two traditional extremes of authoritarian theism and secular humanism. It seeks spiritual depth and transcendence but relies on the individual's inner experience and intuition rather than on outside authority. It accepts a diversity of theological beliefs and ritual observances, so that none of the world's current major religions would "win" over the others. As a recent bumper sticker says, "God is too big to fit inside one religion." Yet it incorporates core beliefs about how people should treat each other.

In most cultures there has been a profound difference between the inner experience of religion by mystics and the religious feeling of average people who observe the mysteries from a distance. Traditionally, average people's religious experience tends to involve ritual, pageantry, a set of rules of conduct, and worship of something "higher" than oneself. In a genuine partnership society, average people's religious experience would become more similar to the experience of mystics. That is, people in general would reach a direct appreciation of our place in the cosmos and its purpose. This would require fluidity and depth of feeling and perception, which eschews formal

rules but integrates all major subsystems of both the mind/brain and the body. It would involve a long-term view of things, a perspective that transcends current needs and stresses to see larger plans.

This kind of religion encourages both people and institutions to be more patient and less hurried than they are in the present. Hence it values contemplation and visionary thinking as well as moral action. Good use of the integrative, planning capacity of the brain's frontal lobes, which integrate reason, emotion, and instinct, becomes a religious obligation.

The traditional notion of God as an external authority figure, distinct from and eternally better than us, would be replaced by an idea from what anthropologist Gregory Bateson termed "the theology of Alcoholics Anonymous" (AA; Bateson, 1972, pp. 331-335). AA's 12-Step Program says that there is a power greater than the self, but that the believer must formulate his or her own understanding of the nature of the power (see for example *Alcoholics Anonymous Comes of Age*, p. 288). It's not a power that can reward or punish, nor is it a dictator. Most important, the higher power is not separate from us but rather includes and is larger than all of us.

Psychotherapy

Individual and group psychotherapy in Western countries has tended to react to overly strict parental and religious control by focusing on individual freedom, self-acceptance, and living in the present. Also, psychotherapy has reacted to society's tendency to over-intellectualize issues by focusing on emotion and intuition. Yet these reactions carry the danger of supporting the excesses of individualistic capitalism. In order to prepare patients or clients for living better in a partnership society, psychotherapy needs to re-integrate concern for others (see Nicholas, 1994) and respect for the intellect. After all, self-care is not only self-indulgence or advancement of one's personal goals, but also includes feeling that one is being useful and compassionate to others. And for many of us, awareness of one's emotions includes acknowledging a genuine enjoyment of intellectual challenges.

A partnership approach to psychotherapy notes the daunting complexity of human mental life and the need for the human brain to bridge a variety of paradoxes to live life at its best (Grossberg, 2000). Respect for the mind's complexity requires that we evaluate an individual's conflicts with regard to the person's level of development (mental, emotional, physical, and spiritual). As Erikson (1950) discussed, the struggles of adult life (e.g., "generativity versus stagnation" and "ego integrity versus despair") deal with different issues than the struggles of adolescence (e.g., "identity versus role confusion") or childhood (e.g., "basic trust versus basic mistrust"). The implications of neural network dynamics support Erikson's general conclusions but suggest there could be wide individual variations in the ages at which conflicts occur. Psychotherapists need to avoid reducing all personal struggles and conflicts to the lowest common denominator, or confusing anxiety about a higher-level need with anxiety about a lower-level need. For example, many people, particularly from oppressed or victimized groups, have difficulty asserting their rights and asking for what they want even when they feel they deserve it. Mainstream psychotherapy tends to regard that as a problem of low self-esteem, but I have argued elsewhere (Levine, 1998b) that it comes from cognitive dissonance between *high* self-esteem and underestimation of one's power to change things. Treating it as a self-esteem issue is potentially harmful because it attributes societal victimization to the individual; also it negates the growth the person may have already made in identifying her or his disempowerment. What is needed instead is a form of assertion training that is strongly integrated with consideration for others.

As Maslow (1968, 1971) pointed out, when lower-level needs have been met, a person may not move immediately toward absolute contentment but instead move to a higher level of discontent! For example, if an underemployed person succeeds in getting a steady job, her or his grumbling about lack of a job might be replaced by grumbling about whether the job expresses her or his deepest aspirations. If the personal fulfillment issues get resolved, that can in turn be replaced by grumbling about the general unfairness of society.

As people make peace with aspects of their lives and take on new challenges, they naturally get anxious about their ability to succeed in more difficult tasks. When someone takes on a new challenge, however, the stress can make her or him revert to sub-optimal behavior patterns that were previously abandoned in easier situations. At those times, other people – including the media, if the person is a public figure, and therapists – may become more critical of her or him than is justified. This happened, for example, to Michael Dukakis when he ran for President in 1988. Dukakis had once lost re-election as Governor of Massachusetts, in part because he often spoke in an overly unemotional tone that didn't connect well with voters. He had overcome that tendency enough to win back his office two years later and serve two successful terms as Governor. Later, when he ran for President and was perceived by some as soft on crime, a reporter asked him how he would react if a criminal raped his wife. In this and other occasions he reverted to his earlier flat affect, which subjected him to sharp media criticism.

Psychotherapists need to show compassion toward those who are experiencing stress from taking on new challenges. They also need to give these people credit for past growth that may be temporarily extinguished by their current stresses. After all, many experiments on animal conditioning show that responses that were once learned and later extinguished can be re-learned faster than they were learned in the first place (Pavlov, 1927; Ricker & Bouton, 1996). Our tendency to be critical of people who make partial efforts in the right direction may be an offshoot of the Western overemphasis on definite solutions (Saul, 1992). The more we as can overcome the bias toward finished solutions and live with temporary incompleteness, the more people will be encouraged to stretch their limits, which is what we need to create and maintain a partnership society.

Politics

A synthetic approach to politics is called for. Such an approach transcends the traditional distinctions of conservative versus liberal but includes the best of each. From traditional liberalism it will gather the notion of activist government that openly

seeks to promote the welfare of average people. (We can see an analog for this form of government in the individual human brain!) From conservatism it will gather the notion that enduring values and communities are important.

One of the more promising current political syntheses in the United States is the *politics of meaning* movement (Lerner, 1987, 2006). Its major proponent, rabbi and magazine editor Michael Lerner, advocates a brand of liberalism that avoids two of liberalism's traditional traps. One of these traps is "the myth of externality", meaning the belief that people make political decisions solely on the basis of narrow economic self-interest – which recent experimental results in decision psychology and behavioral economics argue strongly against. The other liberal trap is "the excessive focus on individual rights" (Lerner, 1987, p.2). Instead, Lerner's vision is of a participatory political system in which people feel a sense of community, and all interest groups engage in mutually respectful dialogue. If small intentional communities (Communities Directory, 1996) are accurate guides, such dialogue can become quite emotional and personal as issues are ironed out.

Hence, our prescriptions for politics are an echo of the notion from utopian fiction that bridges should be built between opposing positions, rather than each side seeking simply to "win." To promote human welfare in our tense and complex global society, we certainly need to take strong stands on many issues including peace, the environment, income inequality, and health care. But politics, like psychotherapy, has suffered from the Western prejudice in favor of reaching definite answers, even if the answers found aren't good ones (Saul, 1992). Presidents and prime ministers are criticized as vacillating or weak if they don't come quickly to decisive action, regardless of the daunting complexity of the problems they deal with. Leaders of the men's movement trace this strain in Western politics to images of masculinity that have grown up over the centuries (Fasteau, 1975; Gerzon, 1982). Political leaders are still predominantly male. Like other men, they feel the need to "prove their manhood" by showing they are strong and not weak, even when the action they take to demonstrate their strength is inappropriate. We hope that the growing influence of women in politics (for

example, as elected heads of state in more than thirty countries) can help us see the value of taking risks on the way to solving these big problems (see Taylor, 2002).

We can see broad visions for where we want to take the world in the next century. But within these visions there should be few preset plans. Rather, we need to experiment, as long as we take care that people don't suffer too much from being "guinea pigs." In any social experiment, those people whose lives are strongly affected by the outcome should also be participants. Also, we need to complement social change with the long-term outlook, suggested by partnership-oriented religion, which allows for contemplation as well as action.

Economics

The partnership approach to economics is discussed thoroughly in Eisler (2007). One of its most important aspects is placing a positive value on caring. This means that care of children, the elderly, and people in need would be considered a positive social value and not a cost or drain on the economy as they are presently considered. Conversely, industrial pollution and armaments manufacturing, which are now considered positive contributions to the GDP, would be considered as negative values. So Eisler (2007) advocates a new method for measuring countries' economic health that incorporates social values; more details are found in Ghosh (2014). Eisler also calls for much better pay and professional training for those engaged in caring professions, including day care workers and home health aides who in the United States are now unlicensed and working at near minimum wage.

Our review of decision psychology points the way toward theory that supports a (world-wide) partnership economy. Traditional economic theory is based on the notion of an all-powerful market in which buyers and sellers, capitalists and laborers are all self-interested actors trying to maximize their own net earnings (called *utility*). While the self-interested utility-maximizing model is still dominant in academic economics departments, there is a growing presence of behavioral economics that takes into account the complexity and plasticity of real human motivations including social

cooperation (e.g., Thaler, 2015). In fact, Thaler and Sunstein (2009) distinguish between the decision-making process of “humans”, who are subject to emotional and contextual influences, and the processes of “econs”, who mechanically follow logical rules (pp. 6-8). An increasing number of Nobel Prizes in economics have gone to individuals whose approach deviates from the classical self-interest model, including Daniel Kahneman, Paul Krugman, Elinor Ostrom, Amartya Sen, and Joseph Stiglitz.

The neuroscience results reviewed in this article indicate that caring makes a positive difference and excessive stress makes a negative difference in human lives, no less in the workplace than anywhere else. Consequently, as Eisler (2007) documents, the choice between an organization being efficient and one that cares for its employees is a false one, because on the average, employees who are well treated are more productive and perform better. Surveys of employee attitudes have consistently shown that supportive working conditions are at least as important as salary in promoting job satisfaction (see, e.g., Happiness in the workplace survey, 2011). This means that employees feel that they are given initiative (“democracy of creativity”), their contributions are respected, and their family and personal needs are honored with flexible time arrangements.

Because of the quantitative nature of what they deal with, economists are often drawn to mathematical modeling. One of the reasons the self-interested, rational, utility-maximizing theory has remained popular is that it is easier to handle mathematically than a theory that also encompasses emotional factors and mutual cooperation. While the mapping between models and data is still less precise, though, a few investigators are starting to build mathematical models of economic behavior that incorporate emotions as well as reason (e.g., Grossberg, 2013; Grossberg & Gutowski, 1987; Levine, 2012; Mengov, 2014; Mukherjee, 2010) and cooperation as well as self-interest (e.g., Levine, 2006b; Lynne, 2006). There is a feedback between theory and practice, so that the emergence of scientific economic theories compatible with a partnership model can encourage the growth of partnership economic structures.

Family and sex

The partnership approach to sex and the family is depicted in Eisler's *Sacred Pleasure: Sex, Myth, and the Politics of the Body* (1995). That book emphasizes that the quality, whether partnership- or dominator-based, of relationships within the family is a microcosm for the quality of relationships in the larger society. Thus it is of prime importance for building partnership relations to replace the patriarchal conception of the father-dominated household with one where all adults, female and male, have roughly equal influence. Between adults and children there will still be some inequality, because children's brains are not fully developed, so that instruction and parental authority are necessary. But the hierarchy between parents or other adults and children is what Eisler calls a hierarchy of actualization, one that emphasizes the development of each child's individual creativity and independence rather than the obedience that the dominator ethic emphasizes (cf. Levine, 2009). The family that results can sometimes be the traditional nuclear family of mother, father, and children but is not restricted to that; a variety of potential extended family arrangements are possible as long as they adhere to the partnership model.

In the partnership model, as Eisler (1995) notes, sexuality for both men and women is treated as a source of pleasure and bonding, not as something dirty or immoral. Heterosexual monogamy is likely to be the most common form of sexual arrangement, but homosexuality is equally accepted if it is part of a loving relationship, and multiplicity of sexual partners (polyamory) is accepted if it is open and based on mutual trust (which occurs in such societies as the Musuo of China, as Eisler documents).

CONCLUSION

Our society's understanding of human brain organization and function has grown explosively since the start of the 21st Century. Already the new knowledge of the brain has permeated the popular press as well as education, psychotherapy, and computer engineering. It is now well established, for example, that brain connections, once thought to be fully formed at birth, are profoundly influenced by experience, including

both nurturing and stressful experience. It is also well established that emotion and cognition, once thought to be in opposition, work together to make sense of a changing environment.

Yet society has not reaped the full benefits of our knowledge about the brain. Engineers are using this knowledge to advance their vision of increasing roles for robots and other artificial intelligence devices, sometimes without regard for the human costs of technology. Psychiatric professionals are using this knowledge to “medicalize” treatment of emotional and mental disorders, sometimes wisely and sometimes unwisely. Now humanists and social reformers need to reclaim the advances in brain science for their own purposes.

The picture that neuroscience, experimental psychology, and neural network theory yield is of a complex dynamical system of interacting subsystems with many mutual influences but no subsystem in total control. In other words, our brains and minds themselves are in many respects analogous to a partnership society. As our scientific knowledge increases, I expect that more and more evidence will emerge that partnership interactions broadly serve to maximize achievement of our biological goals: not just the evolutionary goals of survival and reproduction but also the spiritual goals of meaningfulness and actualization.

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