Cambridge University Press & Assessment
978-0-521-50992-3 — Adaptation and Well-Being
Jay Schulkin
Excerpt
More Information

Introduction

As Aristotle noted long ago, we are, by nature, social animals. Human evolution has increased the importance of social knowledge and social context. Prosocial behavior underlies the moral sensibility that pervades human experience resulting in significant human contact.

Darwin emphasized a fundamental prosocial feature of us, essential for moral judgment. He asserted, "… any animal whatever, endowed with a well-marked social instinct, the parental and filial affections being here included would inevitably acquire a moral sense of conscience, as soon as its intellectual power had become as well or nearly as well developed as in man" (1874: 95). However, in *Descent of Man*, Darwin also noted the "the fewness and the comparative simplicity of the instincts in the higher animals are remarkable in contrast with those of the lower animals" (1874: 65).

Adapting to the social milieu is a fundamental feature of our species. Darwin, like others before and since, understood that we are social animals. What has emerged in *Homo sapiens* has been an elaboration of social contact, the expansion of individual responsibility manifested in specific types of the division of labor in the service of group safety and human well-being and productivity. There has also been a technical expansion resulting in the development of a diverse supply of cognitive resources, including cognitive resources which pitted, at times, deception against social cooperation as conflicting motivations (Dunbar and Shultz, 2007).

We are a vulnerable species; our ontogeny is long and labored and greatly dependent on others. We look to others to gain that important ladder into the social milieu. The long dependency on others is a fundamental feature of our species. The social knowledge we gather in ontogeny represents a critical part of our armament for gaining a foothold in the larger social world; a world in which recognizing others' intentions (e.g., Jaspers, 1913) and gathering practical knowledge are critical. In other words, we come into life prepared to interpret our surroundings as defined by the social milieu, and the degree to which we succeed in this task determines to a great extent our success in coping, achieving and thriving. The fact that we come prepared to recognize others and learn from their experiences is thus a fundamental social behavioral adaptation.

Moreover, what is distinctive about us, although our species is not alone, is the degree to which we share and participate toward common ends; shared intentions linked to the considerations of others is one of our most important cognitive adaptations. We look at others; it is not surprising that vision, shared visual space, and recognition (that we are all looking at the same objects) would come to be important cognitive resources. But it is not simply a cognitive detached event; it is affectively rich, reassuring and rewarding. The motivation to form meaningful contacts is essential for development and for life.

Depicted below are some common themes in our cognitive development, particularly that of social development, in Table I.1 (adapted from Tomasello *et al.*, 1993).

GENES, BRAINS AND BEHAVIOR

Changes in the internal milieu (e.g. hormonal secretion) have been long noted. Human prenatal and postnatal development is long and varied, tied as it is to the necessity of the acquisition of a huge body of knowledge during the early period. There is profound change in brain morphology and development during the protracted neonatal period in varying degrees in most mammals (McCarthy, 2008; O'Doherty *et al.*, 2004). Hormones, such as oxytocin, vital for parturition, for the birth process, lactation, and social attachment, figure throughout the gestational and developmental periods.

Oxytocin is produced in the placenta and the brain and the pituitary gland; the fetus is awash in information molecules as it floats in the amniotic fluid within the safety of its mother. Learning about safety and comfort in the new and harsh external world begins in the immediate postnatal period, as the neonate wails and is quickly allowed to suckle.

When one is trying to understand the behavioral response, the brain must be considered, as well as how oxytocin is regulated in the brain. Steroids such as the gonadal hormones or the adrenal

Table I.1. *Infancy: understanding others as intentional (Tomasello et al., 1993)*

1. Following attention and behavior of others
2. Directing attention and behavior of others
3. Symbolic play with objects
Early childhood: language
1. Linguistic symbols and predication
2. Event categories
3. Narratives
Childhood: multiple perspectives and representational re-descriptions
1. Theory of mind
2. Concrete operations
3. Representational re-description

hormones impact the degree of neuropeptide expression (e.g. oxytocin) that underlies behavioral approach and avoidance systems (see below). The genes that underlie, for instance, the production of the peptide oxytocin, in combination with external circumstance, contribute to developmental outcome (e.g. Carter, 2007). They promote social attachment, or approach behaviors (see Chapter 5). One should note that too much is at stake to put everything into oxytocin for the diverse social behaviors of approach that we note in our everyday lives (Chapters 4 and 5).

Disorders such as autism, for example, appear to be associated with an aberration in the motivation for social contact, expressed as extreme social withdrawal (Baron-Cohen, 1995/2000). It is noteworthy that autism, a devolution in social competence, is more heavily expressed in males, and perhaps is linked to the expression of gonadal steroid regulation or sex-specific organizational changes in the brain (Baron-Cohen *et al.*, 2004), perhaps via oxytocin expression (Hollander, 2003).

The social isolation linked to autism is maddening, perhaps provoking a propounded sense of fear that goes along with the isolation. Isolation of this form is not adaptive and in the case of autism a developmental disability has a strong link to brain function and the genes that regulate diverse information molecules, including that of oxytocin (Carter, 2007).

Perhaps it is not surprising that a basic human form of social contact, namely eye contact, would be so severely degraded in autism (Baron-Cohen, 1995/2000). We all know that the sense of security that we derive when we form solid social bonds is quite comforting; this is

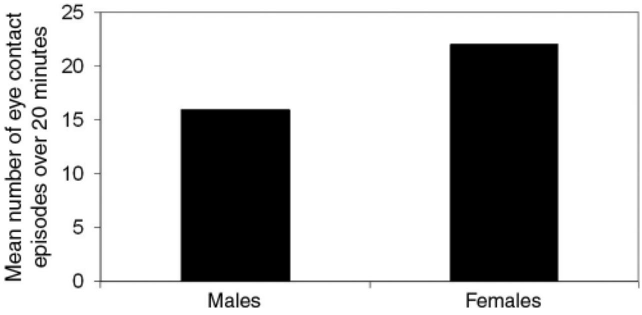

Figure I.1 Females make more eye contact than males (adapted from Baron-Cohen *et al.*, 2004)

impaired in autism. And autism is more pronounced in males (Baron-Cohen *et al.*, 2004). Moreover, quite early in development, male and female children are quite different with regard to eye contact; girls make contact quite a bit more. A diverse set of genes, including those which affect oxytocin, are linked to diverse forms of social devolution (Hollander, 2003).

A diverse set of neuroendocrine systems bound to cognitive capacity is encoded to ensure meaningful contact in development, and throughout our lives; devolution of function (e.g. autism) is the diminishment of this important capacity. Furthermore, our evolution favored social contact: group formation in which diverse cognitive skills facilitate the formation of social bonds. Central peptide systems (e.g. oxytocin, vasopressin), which will be described in subsequent chapters, are linked to social adaptation and function (see also Chapters 5–7).

From the point of view of the brain, two kinds of regulation are taking place: the regulation of the internal milieu, and adaptation and regulation of the social milieu. Both require a brain with diverse physiological and behavioral regulatory systems. In both cases, anticipatory mechanisms underlie adaptation both within the individual and within the social milieu. The greater the degree of social contact and social organization experienced by a human, the greater the trend for cortical expansion (Figure I.2, Dunbar and Shultz, 2007).

Nature selected physiological cognitive systems oriented to social systems. Their evolution and expression underlie the diverse forms of complicated social assessments; group size, for instance, is correlated with cortical expansion (Dunbar and Shultz, 2007). Consider the

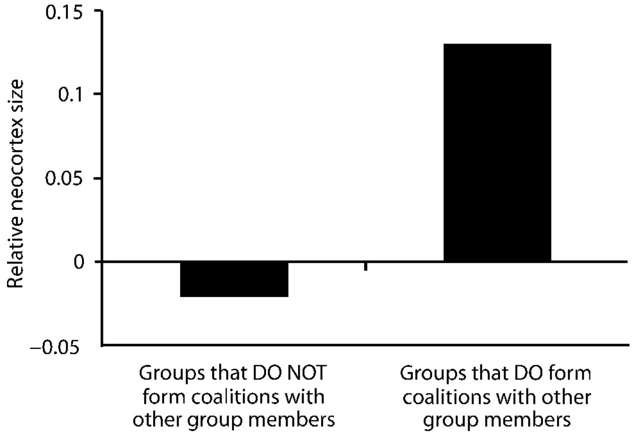

Figure I.2 Social contact in primates is consistently linked to neocortical expression and size (adapted from Dunbar and Shultz, 2007).

complex social relationships of primates the hierarchy, distribution of food resources, shelter protection, dominance, and comfort through co-alliances. Such systems are quite varied and all involve cephalic innervations and expression.

However, social behavior is just one element in our evolutionary ascent, along with an evolved motor system in which subcortical brain regions are pregnant with cognitive capacities. Structural changes in our visual system and bi-pedalism are most definitely core features in our evolutionary ascent.

ALLOSTASIS

The concept of "allostasis" was introduced to take account of the physiology of change and adaptation to diverse circumstances, and to the behavioral and physiological anticipation of future events (Sterling and Eyer, 1988; Sterling, 2004). The concept has been centered in cephalic anticipatory regulation of the internal milieu in the context of the social framework: changing circumstances, adapting to change, and features that are not fully grasped in traditional accounts of homeostatic regulation (such as the maintenance of glucose levels at one level) of the internal milieu (Schulkin, 2003).

Walter Cannon, a student of William James at Harvard at the end of the nineteenth century, popularized the concept of homeostasis; he had an evolving sense of this concept. It was far from a simple one dimensional conception, namely rigidly guarding a simple set point (a body's natural state of balance). Despite Cannon's dispute with his mentor, William James, with regard to James' peripheralist conception of the emotions (e.g. knowing that one is afraid because one's heart is beating fast), Cannon did not emphasize the anticipatory. Rather, he emphasized adaptation and the exhaustion factor that can occur under extreme duress (e.g. voodoo death-shock death); it was just not part of his scientific lexicon, nor was a consideration of behavioral adaptation in the regulation of the internal milieu – that was left for others and for those who were influenced by Cannon (e.g. Richter, 1943) – though Cannon, and later his students, revealed that different parts of the brain were obviously essential for the generation of physiological and behavioral features of adaptation to duress.

In fact, to take account of the social regulation of the internal milieu in addition to the anticipatory mechanisms in maintaining internal viability, another sort of regulatory concept was necessary. In this regard, allostasis is, in part, the process by which an organism achieves internal viability through bodily change of state, which comprises both behavioral and physiological processes that maintain internal parameters within the limits essential for life.

"Allo" means change, whereas "stasis" means stable/same. But the social milieu changes and within this we invoke both cognitive and physiological resources to promote continuity, stability and predicted outcomes – the "allo." Part of "stasis" is about adapting to change to achieve the goal of stability in the face of uncertain circumstances, something all of us know about early in life and continue to experience throughout life; it is not a very abstract concept, it is up close and personal and pervades our experiences. Thus, allostasis is about adapting to change and anticipating the need for change, so as to restore the base state within a new physiological or environmental context (Sterling and Eyer, 1988).

Allostasis developed in response to a need to conceptualize adaptation to change in a way that took account of all the exigencies of the environment and changing circumstance (Wingfield, 2004). The emphasis is on how we achieve internal viability in adapting to changing circumstances within parameters essential for life processes; chronic overactivity of regulatory systems render one vulnerable to pathophysiology.

Allostasis emphasizes regulation that is an adaptation to change; not just in reaction to it, but in anticipation of it (Bauman, 2000). Unpredictable events are a constant feature of the life cycle for most animals, and the need for stability and consistency are a constant characteristic of most animals, within both the physiological and social domains, allostasis is a means of achieving stability in the face of unpredictability.

Life cycles for many species are both predictable and unpredictable. Seasonal changes are predictable, as are light/dark cycles, but unpredictable events obviously pervade the seasonal changes. They include climate changes, such as severe droughts, food shortages or disruption of social status.

Disruption of social status, like most unpredictable events, impacts cortisol levels. Levels of cortisol, for instance, by itself are not a measure of dominance, but of the way in which dominance is achieved (Cavigelli *et al.*, 2003). One recurrent theme is that social support is predictive of cortisol levels, mitigating diverse events which would elevate it in combating adversity (Abbott *et al.*, 2002). Consider what it is like for a wolf pup under the care of the alpha female, who heads the group; when she is killed, the offspring is vulnerable. How vulnerable depends upon social alliances, the age and strength of the offspring, and the terrain and social milieu.

Many different cognitive and physiological systems are involved in anticipating future events, including biological events that factor significantly for survival. The cephalic expansion of cognitive capacity is reflected in these biological systems. Homeostasis has been linked to reflexive reactions, not cognitive anticipation of events and cephalic innervation and regulation of peripheral physiological adaptation. Reflective reactions underlie the immediate sizing up of a social event, through the eye contact and bodily postures, through forms of encoding complex and not so complex social relationships. Think about how fast we are as a species, although we are sometimes utterly mistaken, in our assessment of possible threat or possible social comfort.

One feature of the human brain is the presence of multiple mechanisms that provide the potential for cephalic anticipatory adaptation – that is, the brain constantly attempts to anticipate future events. This is paramount in larger cast social orders, and adaptation is achieved, in part, by cephalic regulation of behavioral and physiological systems in the expression of longer-term adaptation (Sterling and Eyer, 1988).

Traditional conceptions of regulation have typically (though not always) emphasized homeostatic short-term regulation, with further focus on set point stability and short-term contemporaneous adaptation (Cannon, 1916). The expansion of cortical function, in social groups of diverse complexity, entails longer-term regulation.

My emphasis is also on cephalic changes as a result of behavioral adaptation, involving physiology through social relationships, building an environment, use of tools, etc. And this is fundamental to the concept of allostasis. In addition, the concept of allostasis and allostatic overload, pushing the system beyond its adaptive capability, is designed to account for vulnerability to disease by taking into account variations in individual experiences and genetic makeup, and to determine how a lifetime of short- and longer-term adaptation affects wear on the body. Natural aging is one such impact; social inequities and nutritional strains are others. Biology is designed to promote both short- and longer-term viability.

An example is in order: one consequence of high levels of cortisol for long periods of time is vulnerability for memory deterioration via hippocampal damage (McEwen, 1998) and the chronic overactivation of diverse regulatory systems. The hippocampus, an anatomically beautiful structure, is importantly involved in memory, and individuals vulnerable to defects in memory function appear to be chronically compromised by elevated cortisol levels over extended periods of time, a situation that results in neuronal degradation.

In other words, neurons essential for memory are degraded, but the degradation may not be permanent and linked to compensatory responses; diverse growth factors in the brain are regulated by diverse steroid hormones, including estrogen, testosterone and cortisol. The steroids regulate the genes that underlie the expression of diverse growth factors essential for neuronal and other bodily tissue – that is, keeping the tissue afloat and functional – and under diverse conditions these factors are differentially regulated by these various steroids.

On the adaptive side, cortisol is important in the conversion of short- to longer-term memory (McGaugh, 2000). Experiments demonstrate that cortisol, perhaps by facilitating norepinephrine, influences memory formation; it is a fundamental neurotransmitter in the brain which contributes to the consolidation and induction of short- to long-term memory – broadcasting the memory to diverse regions of the brain. In other words, cortisol impacts regions of the amygdala, which is vital for memory formation.

Several examples come to mind: the memory of John Kennedy or Martin Luther King being shot; the Taliban bombing of ancient monumental figures of Buddha; and the bombing of the World Trade Center. The consolidation from short- to longer-term memory is enhanced by the broadcast of this information by the effects of cortisol in the brain (McGaugh, 2000).

I spent years looking at the World Trade Center from my New York apartment. Though living in Washington at the time of the destruction of these buildings by suicide bombers, no doubt the induction of and regulation of diverse neurotransmitter and neuropeptide systems have facilitated the stability of that memory.

Put slightly differently, the induction of the neurotransmitters related to adrenaline in the brain, and the regulation of their expression in diverse regions of the brain (e.g. amygdala, hippocampus, regions of the neocortex), then broadcasts the memory event to diverse regions of the brain that underlie memory. Importantly, cortisol has diverse effects on end organ systems in regulating glycogenesis and whole body regulation, and one such form of regulation involves central neurotransmitters and the facilitation of memory formation. Memory is the key to a consideration to the self; no memory no self, is one suggestion.

There is an important social adaptation designed to reduce elevated levels of cortisol back down to normal. Social attachment – the formation of core safe (or relatively safe) attachments – provides feedback on the expression of steroid levels, such as cortisol, and the regulation of the internal milieu.

The emphasis, however, is on social competence (which would include cooperative behavior in tool use) but also, since we are social animals, an evolved set of anticipatory mechanisms that facilitated the regulation of the internal milieu amidst an expanding social milieu. And these behavioral adaptations impact the brain directly – evolution selected for behavioral adaptations that feed back directly onto cephalic function.

REGULATION

Regulation means many things. It surely means anticipation of events, for instance, anticipation and absorption of food resources vital for bodily functions. Hoarding resources in anticipation of metabolic needs and in anticipation of seasonal needs is not an uncommon behavior (Wingfield, 2004).

Cephalic organization underlies behavioral adaptation. Consider one example: Curt Richter, a psychobiologist at Johns Hopkins, demonstrated in his laboratory a well-known ethological fact about many animals in nature. The laboratory rat constructs a nest to keep warm as a form of thermal regulation in anticipation of temperature demands. It is a fairly common occurrence in humans as well; tool use combined

Table I.2. *Cephalic function and ingestive behavior (Power and Schulkin, 2009)*

Cephalic/Physiological	Organ	Function
Salivation	Mouth	Lubrication, begin digestion
Gastric acid secretion	Stomach	Hydrolysis of food
CCK	Small Intestine	Short-term feeding
Insulin	Pancreas	Regulates glucose and fat storage
Leptin	Adipose tissue, stomach	Reduces appetite
Ghrelin	Stomach	Stimulates appetite, fat absorption

with anticipatory activity (e.g. more than reaction to maintaining one set point) is a core feature cephalic expansion into the regulation of the internal and social milieu.

Cephalic machinations integrate our internal physiology by behavioral regulation (Richter, 1943), such as the rich innervation of peripheral sites or the activation of peripheral sites by vagal efferent projections into sites along the digestive tract.

Importantly, cortical sites (e.g. the frontal cortex) project to these brainstem sites; expansion of cortical function into larger forms of visceral control is a core theme throughout this book, and reveal a diverse anticipatory regulation of the internal milieu.

Diverse anticipatory systems are expressed as we are about to ingest a food resource, many of which are the rich array of information molecules expressed in the brain and peripheral nervous system in the absorption and utilization of food resources (Swanson, 2000). A partial list is depicted in Table I.2.

Peptide hormones in this case are expressed in both the peripheral and central nervous system, and, of course, they work in the context of the larger physiological and behavioral control of food ingestion (Herbert, 1993).

Pavlov, (1927) described a “cephalic phase,” an anticipatory response to food ingestion; insulin is secreted in anticipation of food. These events are cephalic; the context of food passing through the oral cavity facilities the anticipation of utilizing and distributing the vital food resources, and, therefore, in this context insulin is secreted in advance of absorbing the nutrients (Powley, 1977).