The evolution of self-image: a review on theory and methodology

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Abstract

This article provides an overview of the literature about the evolution of self-image. First we will discuss the basic principles of evolutionary psychology. Second, we will discuss the methodology used in research to measure self-concept. Next we will discuss evolutionary theory about the cognitive capabilities fundamental to self-image, followed by an discussion about the evolutionary theory of self-image itself. Then we will discuss self-concept in animals. Lastly, we will posit an association between self-image and the free-energy principle. We will conclude that the possibility to predict future social events, and to act on these predictions, form the main evolutionary advantage of self-image.

Keywords: evolutionary psychology, evolution, mark and mirror test, self-image, self-concept, self-awareness, theory of mind, free-energy principle.

Introduction

The theory of evolution is one of most influential theories in modern science. It has survived major revisions since Darwin set sail on the Beagle in the early 19th century. Today evolutionary thought is alive among scientists studying psychology, mainly in the field of comparative neuroscience. The study of social cognition is being greatly influenced by evolutionary scientific research, as is the study of self-image, which is an important field of inquiry in social cognition. How did evolutionary processes result in something as complex as our self-image? What advantage did our ancestors have in terms of natural selection that resulted in them having more descendants? These are very interesting scientific questions that are both very difficult to answer. Yet if we propose valid answers to these questions, we would be able to make scientific predictions for future research that would be capable of testing the strength of the theory of evolution. Any answers will be closely related to the function of self-image, and therefore could be applicable to settings like high-schools, business, social service agencies and prison—places that serve or employ people who may be experiencing problems related to the self-images. For these reasons, it is useful to know about the evolution of self-image, before proceeding to a discussion of its relevance, which will be discussed in other articles in this magazine.

A full review of all the scientific research on this topic is beyond the scope of this article. Here we will discuss some of the more important theories and aspects of the evolutionary thoughts on self-image. First, we will present a short introduction to the basics of evolutionary psychology. Then we will review the methodology

of evolutionary psychology in order to broaden our understanding of the literature under review. This will include an interesting look at the arguments from both proponents and opponents of these methodologies. Then definitions of self-image and self-concept will be discussed, together with an identification of the specific fundamental cognitive functions involved, and which are necessary for the construction of a comprehensive self-image. The components essential to this process are consciousness, self-awareness, self-perception, theory of mind, episodic memory, and semantic memory. Afterward, we will discuss the evolutionary advantages that the segregated fundamental cognitive functions have for animals and mankind. We will then discuss the evolutionary theory of self-image, which enables an integrated overview of the segregated fundamental functions of self-image. We will state that the evolutionary advantage of self-image is that it creates a possibility to make a more accurate prediction of future social situations. Then we will discuss the existence of self-concept in other animals. We will finish by proposing a parallel between self-image in an evolutionary perspective and the theory of the free-energy principle that tries to explain the functioning of the brain as a whole (Friston, 2010), thereby building a bridge between the evolutionary advantages of self-image and the complex behavior in terms of which self-image can have an important influence.

An overview of Evolutionary Psychology

To understand the evolutionary perspective regarding self-image, it is important to know the basic principles of evolution and evolutionary

psychology. The core idea in evolutionary theory has remained the same since its introduction in the 19th century. Traits that encourage survival and reproduction are adaptive to the environment, and therefore have a higher chance of being passed to future generations (Gazzaniga, Ivry & Mangun, 2009). This idea is called natural selection. Darwin and Wallace observed that individual organisms in a population are not identical. These differences seemed to be heritable. They also observed that because of these partially heritable differences, not every individual organism has an equal chance of reproducing. This is how the most adaptive traits of a population are selected by nature. Today more modern studies often research evolution by examining genes. A more modern look at the evolutionary mechanism discovered by Darwin reveals that natural selection acts on the existing phenotypes within a given population (Gazzaniga et al., 2009). An adaptation is a trait of an organism that contributes to its fitness, which can in turn be seen as the measurement of how capable an organism is of reproducing.

Modern evolutionary scientists distinguish between different kinds of evolution (Gazzaniga et al., 2009). Exaptation is such an example. Exaptation refers to a structure of an organism that originally served a purpose but that has to come to be co-opted for another purpose. Plesiomorpism is a trait shared by a particular subset of animals, like a spine in vertebrate animals. A homoplasy is a trait that looks similar across species but that does not originate as a result of shared ancestry. Gazzaniga, Ivry and Mangun (2009) report that in cats an area within the brain, called the posteromedial lateral suprasilvian area, shows remarkable functional resemblance to human area MT (or visual area 5, which is involved in perceiving motion), although animals that have a more recent shared ancestry with humans do not show this resemblance. When such an evolutionary resemblance occurs it is called convergent evolution. As a last example, homology is a trait that is repeated through ancestry, like the hand of an ape and the hand of a human.

Modern evolutionary psychological research mostly takes place within the discipline of comparative neuroscience. It differs from other forms of evolutionary psychology in that it is more system-oriented. But how do these scientists measure something as abstract as self-concept?

Measuring self-concept

One major problem that arises when studying self-concept in animals is the temptation to ascribe particular human states of mind and intent to the animal in question – a phenomenon known as anthropomorphism (Piggins & Phillips, 1998). Unfortunately, we will never be able to fully experience the world of another species. According to Longuet-Higgins (1994, in Piggins & Phillips, 1998) Westerners gain insight into the inner reality of other species only when they can imagine "what it feels like" to be that other species. The same article concluded, in considering consciousness as the "state of being that enables the perceiver to perceive, or the observer to observe", that a scientific explanation of consciousness is a logical absurdity because it would entail explaining the existence of observers in terms of their own observations. It could be argued that the greater the difference, relative to humans, in brain capacity, behavioral repertoire, and an ability to exhibit flexibility of response, the less the chance there is of even coming close to understanding the self-concept of a given species (Piggins & Phillips, 1998).

There is a widely used test for measuring self-concept: the "mark and the mirror test". We will discuss this test in detail, because a great deal of research dealing with self-concept is based on it. In the mark and the mirror test, animals or children get a dot painted on their face. When they look in the mirror and see their face, if they realize that the face is their own, they will realize they themselves must have a dot painted on their forehead or nose, and they will react to that. To make sure the reaction is not because they can feel the paint on their foreheads, the same test is done with invisible paint (de Waal, 1996/2007). When animals or children realize the creature in the mirror must be themselves, most scientists assume that the creatures are displaying self-awareness (Bard, Todd, Bernier, Love & Leavens, 2006). This assumption of self-awareness includes introspection and mental-state attribution (Reiss & Marino, 2001). This test does not always yield the same result, which leads to a lot of criticism of its reliability. The theory behind self-recognition in the mirror is also an object of discussion.

One important reason why results for the mark and mirror test (hence the mirror test) can vary, is that there are actually two versions of this test. A comparative psychologist, Gallup (1970, in Bard et al., 2006), developed a mirror test for

monkeys, independently from Amsterdam (1972, in Bard et. al., 2006), a clinical child psychologist who developed a mirror test for use with infant humans. Both Gallup and Amsterdam used a mark and controlled how the mark was discovered. In the testing procedures are two main similarities: maximizing motivation to discover the mark and making natural behavior appear. However, the two use dramatically different methods to achieve these assumptions. (Bard et al., 2006). Besides this, the operationalization of discovering the dot and thereby realizing the image in the mirror is oneself is very different in the two versions of the test. Self-recognition in the mirror in developmental studies is assumed when an infant shows a variety of verbal and nonverbal behaviors, including a single touch of the dot. In comparative studies, self-recognition in the mirror is not assumed until the animal touches the dot several times (Bard et. al., 2006). By measuring the same construct, the use of two different measurements is of course not desirable. The different approaches to self recognition in humans and animals make it difficult to compare self-recognition in humans and other species. It is helpful to know if the developmental or the comparative approach is used by making conclusions about self-recognition in evolutionary perspective.

Theories that explain mirror self-recognition can be inductive or deductive. Available evidence suggests both approaches are valid to some degree (Mitchell, 1993). Inductive theories suggest that an organism makes an inductive inference by utilizing mature kinesthetic-visual matching and deploying an understanding of mirror-correspondence. The deductive theory states that an organism makes a deductive inference. Under these conditions, self-recognition in the mirror is dependent on the subject fully understanding object permanence and mirror-correspondence and objectifying body parts (Mitchell, 1993). According to Mitchell (1993) both theories suggest that limited self-knowledge is required for passing the mirror-test. However, recognizing oneself in the mirror doesn't have to be a criterion for passing the test. Human infants, for example, can also be seen to try to wipe a mark off their face upon observing another human with a mark on his or her face, so passing the test can also be the result of an organism's wondering if it is similar to other organisms in having a mark on its face, a phenomenon referred to as kinesthetic-visual matching. Mitchell (1993) also suggests that self-

recognition is variable in different species and during ontogeny, such that variable explanations may be required for different species at different ages.

The validation of the mirror test is also questioned. The mirror test is just a single technique based solely on visual cues. According to Bekoff (2003), it is essential to expand studies of self-concept to include investigations of the role of sensory modalities other than vision, especially for animals that cannot recognize themselves in a mirror. Numerous animals rely more heavily on auditory and olfactory stimuli than on visual input during many of their social encounters. It is also important to determine whether and how cues from different modalities might interact with one another, because Bekoff (2003) suggests that a sense of self relies on a composite signal that results from an integration of stimuli from different modalities. The mirror self recognition test is not species-fair, in that individual specimens of many species do not naturally make self-directed movements toward their head: for example, gorillas tend to avoid eye-contact (Bekoff, 2003), and some animals are simply not capable of touching their own bodies.

Another reason for the limited validity of the mirror test has to do with the fact that, in most studies, only some individual specimens of a species show evidence of self-concept. If this means that the species is capable of developing self-concept, why didn't other individuals with almost the same life-circumstances develop it? And if this means that every animal from that species has a self-concept, why do only some individual specimens display it during the mirror test? Another observation is that it is possible that, even though the tested animals never saw a mirror before, they learned something about themselves by seeing their reflections in water (Salzen & Cornell, 1968, in Bekoff, 2003).

Because researchers cannot see the minds of others directly, it would be helpful to use neuro-imaging technique. Science is not yet capable of diagnosing a sense of self with the help of neuro-imaging, but this is a very promising avenue for future research. Another way in which self-concept could be made clear in animals is identifying those behavior patterns that are instances of consciousnesses and self. But in this field as well, there is a lot of research needed before any valid conclusion can be drawn about those behaviors. Another ongoing debate has to do with whether

language is a necessary prerequisite for self-consciousness (Bekoff, 2003). It is thus obvious that the study of self-concept is still in its infancy, and requires considerably more development. However, the introduction of the mirror test has made it possible to draw some conclusions about whether an organism has at least some sense of self.

The foundations of self-image

The ability to think about oneself in a highly complex way is something that distinguishes humans from animals. Self-image is a major factor in human social behavior, and therefore a widely studied topic in the social sciences. A term that is synonymous with self-image is "self-concept", which can be defined as a set of attributes, abilities, attitudes, and values that an individual believes defines who he or she is (Berk, 2009). In animal research, "self-concept" is the most commonly used term. In research on human subjects both terms are used. Because self-image and self-concept are both used in the literature, we will use "self-image" in a human context and "self-concept" in an animal context throughout the remainder of this text in order to draw a distinction between the more complex human self-image as compared to the self-concept of some other species. Self-image comprises a minimum of three components: a sense of continuity, a sense of personal agency and a sense of identity (Gallup, 1998). It is difficult to supply a comprehensive identification of each and every cognitive ability needed for something as complex as self-image. We limit our examination here to the following important variables: self-awareness, self-perception, theory of mind, episodic memory and semantic memory. Of course, all the fundamental cognitive capabilities presume an already existing consciousness: a creature capable of self-concept always presumes consciousness.

A concept that is closely related to self-concept is self-perception. Self-perception is the process of perceiving oneself (Gazzaniga et al., 2009). The outcome of this process could be called a self-percept. We can thus define self-concept as the product of a large collection of self-perceptions. To be capable of self-perception, an animal would need to posses the attribute of self-awareness, which is the ability to concentrate on oneself introspectively, and to know or understand one's own mental states (Focquaert & Platek, 2007). Another cognitive ability that is fundamentally needed for self-concept is a theory of mind which, in reference to an animal or a human, is the insight

that other animals or humans also have consciousness, a state of mind, and the ability to perceive (Santos, Flombaum & Phillips, 2007). Other prominent cognitive abilities needed for a self-concept are episodic and semantic memory systems (Klein, Cosmides, Gangi, Jackson, Tooby & Costabile, 2009). These systems are used to store self-perceptions and to draw inferences about oneself that come to which form part of the self-concept.

Evolutionary theories on the foundations of self-image

Some species don't react the same way every time they receive the same stimulus. They have to be flexible, which probably means that they have to interpret the world consciously. Behavioral flexibility is often seen as one of the main reasons why animals might need to process information consciously and maybe even to know who they are (Bekoff, 2003). A great deal of research is being conducted on the neural link between this behavioral flexibility and consciousness. For example, there is an apparent link between such variables as forebrain size, feeding innovations and behavioral flexibility in birds, between the size of the brain relative to the size of the body, and behavioral flexibility and sociality in mammals (Bekoff, 2002, in Bekoff, 2003). Such correlations support the evolutionary theory of self-concept.

The notion of behavioral flexibility is relevant to attributions of consciousness and self because it is connected to an organism's monitoring of its own performance. An organism that cannot detect when its states misrepresent its environment will be limited with respect to the adjustments it can make when those states are caused by abnormal or unpredictable stimuli (Bekoff, 2003). According to research in the field of cognitive ethology, consciousness has evolved to allow adaptively flexible behavior. Thus, adaptively flexible behavior provides evidence of consciousness.

It has also been suggested that consciousness evolved in social situations in which it is important to be able to anticipate the flexible and adaptive behavior of others. This is in line with the view on behavioral flexibility, but also suggests that complex social skills might be taken as evidence of consciousness (Bekoff, 2003). However, as seen in the section of the present paper about self-concept in animals, monkeys do not display self-awareness during the mark and the mirror test (Schumaker & Swartz, 2002, in Bekoff,

2003). Because monkeys, like apes, live in social groups, it can be concluded that a social group alone is not sufficient for developing a self-concept.

Other ideas have been studied in connection with attributions of consciousness. The integration of information from multisensory sources, such as sight, smell and hearing, is one of them. In this view, consciousness gives animals the opportunity to gain knowledge or information about their environment, while perceptual capacities provide evidence of consciousness. It has also been asserted that consciousness enables the development of language skills (Bekoff, 2003). These ideas require a great deal of further study.

The ability to become the object of one's own attention is referred to as self-awareness. The main advantage of self-awareness is that it facilitates the understanding of others. When an organism is self-aware, that is, being aware of being aware, it becomes possible for it to make inferences of awareness in others (Gallup, 1998). Being aware of the awareness of others makes it possible to attribute states of mind to those others. Self-awareness probably had an evolutionary advantage for our ancestors, primarily because of the benefits it affords for understanding others (Focquaert & Platek, 2007). This awareness of others is often referred to as other-awareness. But these researchers also stress the importance of self-awareness to the individual. Understanding our own behavior is crucial for maintaining long-term goal-directed behavior. Self-awareness and other-awareness make it possible to experience social emotions like shame and guilt.

Closely related and maybe even interchangeable with other-awareness is the theory of mind. As noted earlier, a theory of mind refers to the insight that another animal or human also has a consciousness, a state of mind, and the ability to perceive (Santos, Flombaum & Phillips, 2007). It refers to an inference about the existence of a mind in other individuals. It is called a "theory" of mind due to the inferential character of this insight. In other words, there is no possible way for an individual to check his assumption of the existence of consciousness in another individual. Human theory of mind differs from non-human primate theory of mind with regard to the degree of abstraction. Chimpanzee theory of mind, for example, is mostly related to behavioral expressions of the state of minds, like the physical expression of anger. Human theory of mind is thought to be more abstract, involving the other's

emotional state of mind even when not manifested in physical terms (Focquaert, Braeckman & Platek, 2008).

Introspection seems to be a quality that is unique to humans. Nicholas Humprey (1986, in Focquart et al., 2008) proposed that the evolution of an "inner eye" allowed for the development of the theory of mind. One claim is that this ability to introspect is the cause of difference in abstraction between human and non-human primate theory of mind. I has been suggested that this ability of humans to attribute emotional states of mind to other individuals resulted in the development of a wide array of cooperative behaviors (Focquaert & Platek, 2007). But, according to evolutionary theory, human ancestors with a more complex theory of mind had an advantage over other primates that were capable of no more than a primitive theory of mind. One hypothesis is that primitive man's habitat of open spaces afforded an opportunity to develop cooperative behavior, which became an advantage in terms of natural selection. This habitat differed dramatically from that of other primates. Within a context of open land, human ancestors needed to hunt and gather, and to work together to survive. Natural selection selected those who were most fit, and those primitive men who were most fit were those who were most capable of social behavior (Focquaert & Platek, 2007). Such individuals were those who were most capable of developing self-awareness and theory of mind.

When we look more closely at the components of self-image, the above sections clearly describes the evolutionary development of a sense of personal agency. But, as stated earlier, self-image has a minimum of two other components, namely a sense of continuity and a sense of identity (Gallup, 1998). In order for any sense of continuity and identity to develop, memories of one's personal history must be stored. Two kinds of memory are especially relevant to the development of self-image. These are episodic and semantic long-term memory (Klein, Cosmides, Gangi, Jackson, Tooby & Costabile, 2009). In episodic memory, information about our personal history is stored (Ashcraft & Radvansky, 2010). It involves conscious memories of past events, like graduation and maybe the time you were involved in a car-accident. Semantic memory is the kind of memory that memorizes facts, like what personality, anger, lobsters and elephants are. Without episodic and semantic memories, one would have no memories

to base a self-image on. But how is long-term memory involved in self-image?

First, there is a need to be clear that all kinds of memory are important for our memory system. Without sensory and working memory, information would not be stored in long-term memory, although this does sometimes happen even in patients with major impairment of working memory (Gazzaniga et al., 2009). But, again, in order not to stray from the subject of the present paper, we will not consider those kinds of memory, and will only review the evolution of the most relevant forms of memory.

Human hunter-gatherer societies seem to have been highly social and stable (Klein et al., 2009). These circumstances were conducive to personality development and eliciting the making of predictions. Models that can predict future behavior of other individuals can maximize pay-offs created by these interactions. There is widespread agreement among memory theorists that episodic and semantic long-term memory store information about one's own and other individuals' personality. Klein et al. (2009) present a research-based model of episodic and semantic memory based on self and other conception. This model consists of three components. First, long-term episodic memories about past informative mental trait behavior about oneself or another individual is summarized in long-term semantic memory. Then, based on these summaries, trait judgments are made without reference to those episodic memories. In the final stage, trait judgements exist independently of earlier episodic memories. This model can explain how semantic and episodic memory plays a role in forming a sense of identity, as well as a sense of continuity. The trait judgments about oneself or another individual resulting from this model can be used to predict future outcomes in social behavior. More importantly, Klein et al. (2009) report some scientific evidence that supports their model.

Evolutionary theory of self-image

Now that we have reviewed how self-awareness, theory of mind, introspection, semantic memory and episodic memory are all fundamental for a complex human-like self-image, we will focus on an integration of these concepts. Focquaert and Platek (2007) claim that having an "I" to project into the future makes it possible to plan our behavior with reference to our wants, desires, intentions, beliefs and emotions, which in turn confers upon humans a motivation to pursue very diverse, future-directed, and long-term goals. A comprehensive explanation of the evolutionary advantage of self-image should include such a future-orientation. Our self-image comprises numerous self-perceptions. We have seen that these self-perceptions are stored in our episodic memory (Klein et al., 2009). These self-perceptions will be summarized and then stored as a self-image in semantic memory independently of these self-perceptions. In order to perceive oneself, one needs to be self-aware (Gallup,1998). The main difference between human self-image and animal self-concept is, as stated above, a matter of complexity. In order to have a complex self-image, one needs to be capable of introspection. The ability to introspect on one's own emotions and thoughts is probably unique to human beings (Humphrey, 1986, in Focquaert et al., 2008).

Having a self-image to project into the future makes it possible to plan our behavior, and to make a mental social trial and error analysis (Focquaert, Braeckman & Platek, 2008). Klein et al. (2009) pointed out that there was a clear evolutionary benefit for those individuals who could maximize pay-offs from social interaction. A mental analysis is much less costly than an actual trial and error strategy in maximizing pay-offs. The development of a comprehensive self-image is probably an adaptation to the prehistoric human habitat of open land, where food and shelter were harder to secure than in the habitat of most monkeys. But humans are also a highly social species, requiring more than food and a mate in order to survive. Humans need to function in a complex social world in which we encounter numerous others. These others behave in ways that can be predicted, interpreted and sometimes manipulated (Santos, Flombaum & Phillips, 2007). Failing to master these social skills would often lead to a lesser degree of fitness than that of more social individuals. A comprehensive self-image, which includes knowing what skills one has or how others perceived the individual, could then be used to make more accurate predictions of future situations. Note that stating the advantage of self-image this way includes self-awareness, self-perception, memory and theory of mind. As evolutionary theory predicts, it seems that a comprehensive self-image made it possible for an individual to be fit for natural selection.

Self-concept in animals

If humans acquired a self-image as a product of evolution, does that mean that (some) animals have (some) kind of self-image as well? The answer is probably yes, which is an argument for the theory of evolution. We will discuss some important ideas in this connection. Afterward we will identify which animals appear to posses the attribute of self-image.

According to Bekoff (2003), comparative and evolutionary studies of behavior suggest that some animals would clearly benefit from having some notion of self, whereas for others it might make little difference as they go about their daily activities. There are numerous different points of view regarding this issue. One theory is that there are various degrees of self. Bekoff (2003) thinks that those degrees do not constitute a hierarchy, in that there are no better or worse conditions. An evolutionary view does not, according to him, allow for the assignment of value to different sorts of conscious states, when they are viewed as adaptation to a species-specific lifestyle. Darwin stated that the difference in mind between man and the higher animals, great as it is, is one of degree rather than kind (Darwin, 1936, in Bekoff, 2003). Some researchers see a possible relationship between perceptual consciousness and self-consciousness, which is connected with the above statement.

Consciousness has many different definitions, which should not be an excuse for researchers to disagree about species having consciousness. If being conscious means only that one is aware of one's surroundings, then many animals are obviously conscious. Awareness of this sort is called perceptual consciousness (Bekoff, 2003). It is when they discuss self-awareness (self-consciousness) in animals that researchers begin to disagree. As said before, many researchers argue that there are different degrees of consciousness. In addition to perceptual consciousness, there is also what some argue is a higher degree or level of consciousness, namely self-consciousness – an awareness of who one is in the world (Bekoff, 2003). Measuring animal consciousness and self-reflection is often done by the mark and the mirror test, which was previously discussed. In short, self-awareness is assumed when a creature recognizes itself in the mirror.

As an argument for the theory of evolution of self-image, the major fundamental assumption of self-awareness has been made with reference to species that stand closest to humans in terms of complexity of development. Chimpanzees are genetically closer to humans than monkeys like macaques. Indeed, chimpanzees seem to have self-awareness, as they "pass" the "mark and mirror" test. Other apes seem to display some kind of self awareness as well: some orangutans and gorillas also seem to react to the ape in the mirror as if it were oneself (Bekoff, 2003). Monkeys however, don't seem to have self awareness (Schumaker & Swartz, 2002, in Bekoff, 2003). In one experiment, chimpanzees usually stole food only when the experimenter's gaze was not directed at the food (Focquaert & Platek, 2007). In another condition, in which the experimenter was focusing his gaze at the food, chimpanzees stole significantly less food. Such a result has never been observed with macaques. This suggests that chimpanzees show social emotions, which requires self-awareness. This particular experiment illustrates the importance of self-awareness, not only in reference to more emphatically expressive behaviors but also in terms of deceptive actions. Numerous experiments demonstrate this relationship between being capable of mirror self-recognition and mental-state attribution.

An interesting observation is that elephants (de Waal, 1996/2007) and dolphins (Reiss & Marino, 2000) also have, according to the mark and the mirror test, self-awareness, and therefore some kind of self-concept. It seems that self-awareness developed among different species, and therefore we can state that at least some benefits of having a self-concept were present for all these animals.

Many animals also behave "as if " they have a sense of self, that is, in a manner that shows that they have some sense of their own bodies, and that they know that their bodies are not the bodies of others. Whether body-awareness also indicates self-awareness - that individuals know *who* they are - remains a mystery (Bekoff, 2003).

Self-image and the free-energy principle

In the theoretical sections above, it was stated that the primary evolutionary advantage of a self-image was the ability to predict future social situations with more accuracy, thereby maximizing payoffs created by social interactions. Another question is whether this evolutionary advantaging function of self-image is different from other brain functions. One recently introduced but promising theory about the functioning of the brain can shed light on this

question, thereby marking a parallel between the evolutionary function of self-image and a wide array of other behaviors. This theory is called the free-energy principle.

The free energy principle states that any self-organizing system that is at equilibrium with its environment must minimize its free energy (Friston, 2010). This theory is inspired by the second law of thermodynamics of physics. In short, this second law says that, in any system, the amount of chaos can only increase, for the simple reason that there are more ways to have chaos than to have an equilibrium. Somehow, biological systems (like humans and animals) seem to escape this second law of thermodynamics. According to the theory of free energy, this can only be the case when biological agents minimize the long-term average of environmental surprises. Stated more specifically in reference to humans, the free energy principle posits that humans need to make sure that their sensory entropy (perceived amount of chaos) stays as low as possible in order to stay as close as possible to a state of equilibrium. Free energy is the difference between a given objective situation and the predicted situation, which is always a positive quantity (for a very technical review of this theory, see Friston, 2010).

This theory is not limited to observable behavior, or even conscious behavior. This statement also has implications for the neurobiology and other facets of psychology. Perception can optimize prediction, and action based on these predictions can in turn minimize prediction errors. For example, the learning of an organism, like the well-known examples of classical conditioning, can be explained in such afashion, as can the motivational components of emotion and reason.

What is most relevant to our discussion of self-image is that this theory claims a future-oriented predictive character for the functioning of the brain as a whole. The function of self-image is thus similar to other brain functions. Defined in a way that suits the free-energy principle, the function of self-image is to help minimize the free energy experienced by a human being by predicting social situations and acting upon these predictions, thereby keeping an individual as close to a state of equilibrium as possible. This "tool" that helps maintain an equilibrium proved to be an evolutionary advantage to individuals who possessed it.

Summary

In this article, we discussed the major assumptions of the evolutionary theory of self-image as well as its methodology. As we saw, an important idea of the evolutionary theory is that traits that promote survival and reproduction are adaptive to the environment, and therefore have an increased chance of being passed on to future generations (Gazzaniga et. al., 2009). We concluded that the possibility to predict future social events, and to act on these predictions, form the main evolutionary advantage of self-image.

Because self-image is a trait that humans and some animals share, it must have had some kind of evolutionary advantage. As we saw, such possible advantages are behavioral flexibility and the planning of behavior, both results of having a self-concept. Scientists measure self-concept using the mark and the mirror test, a test that assumes that if creatures recognize themselves in the mirror, they must have some kind of self-concept. Some animals have a self-concept as well.

A self-image comprises a minimum of three components: a sense of continuity, a sense of personal agency and a sense of identity (Gallup, 1998). The major cognitive abilities that are assumed to be part of a self-concept are self-awareness, self-perception, theory of mind, episodic memory and semantic memory.

At the end of this article, an association was posited between self-image and the free-energy principle. Self-image is a complex concept, and a great deal of the evolution of self-image is still unknown. But what is known is very interesting, and can hopefully help us come to understand the most fundamental facts concerning self-image.

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