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Evolution of Self

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Synonyms

Consciousness; Metacognition; Self-awareness; Self-consciousness; Self-reflection; Self-thought

Definition

The term "the self" is broad. It can encompass: (1) knowledge that one is separate and distinct from others, (2) knowledge about the degree to which one is consistent over time, (3) knowledge about how one is a causal agent in the world, (4) information about the attributes (e.g., appearance, personality traits, habits) that one possesses, (5) information about one's goals or motives as well as plans to execute them, (6) knowledge about one's significant roles and relationships, (7) the result of judgments made about oneself, and (8) feelings or emotions that one experiences in response to self-thought.

Introduction

People experience "a sense of self." This may include ideas about how they look, who they are now, how they were in the past, and what they have done in the past. They have the experience that *they* (not an outside agency) do things, and that *they* (and not an outside agency) are the source of their own thoughts. Scholars have long been captivated by the study of the origins, functions, and functioning of this sense of self, and the long and intensive study of this topic has generated a voluminous empirical and theoretical literature (for a sampling, see Leary and Tangney 2012). Indeed, self-awareness has been called "arguably the most fundamental issue in psychology . . ." (Rochat 2003).

One proposition in the self literature is that the mental experiences linked to the self have emerged via evolution (Sedikides et al. 2006). This evolutionary perspective reflects the following assumptions: (1) some organism's psychological characteristics are rooted in genetics; (2) these genetically influenced psychological characteristics will spontaneously vary across organisms in a population; (3) some characteristics are a better fit to an organism's environment than are others; (4) those individuals who possess the advantageous psychological characteristics will be especially effective in the organism's environment, which will contribute to the organism being particularly successful in reproductive activities; (5) reproductive success will lead to a subsequent

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species increase in the extent to which the advantageous characteristics occur in the population; and (6) this shift in characteristics will be accompanied by continuing variability among individuals in the population (such variability is a precondition for evolution).

These assumptions have several implications for the patterns of data that one should observe when searching for evidence related to the self. One implication is that the human experiences of self are linked to physical elements of the body (e.g., genetics, brain structure, brain function). A second implication is that the current human experience of the self may not match the experience of the self in early species members (or in earlier hominid species), but may have changed over time. A third implication of an evolutionary approach to the emergence of the human self is that at least some self-like capabilities may be shared with nonhuman species. A fourth implication is that the self should be adaptively functional. This chapter briefly elaborates on these implications and presents evidence.

None of the relevant sources of evidence is conclusive on its own. For example, although high current trait functionality is consistent with an evolutionary perspective, it does not constitute sufficient evidence for it. A trait can be functional in a given environment, but can still be solely derived from experience (e.g., pathogen exposure). Moreover, even when rooted in natural selection, trait functionality can shift across the evolutionary timescale. A trait may have initially evolved in response to a given set of environmental selection pressures, but, as time progresses, selection of the trait might be governed by a set of environmental pressures that are entirely different from the ones that were originally responsible for its selection.

Another potential concern is that traits exhibited by a species are simply side effects that emerge from the process of selection, but they are not themselves a focus of those selection pressures. For example, evolution may have worked to promote the production of neurons that are densely interconnected with other neurons. If one collects enough neurons, if the neurons are of the correct type, and if the neurons are interconnected in the right way, then the sense of self may spontaneously emerge from the resulting system. Moreover, this sense of self may be functional. Thus, even if humans can be shown to have a biologically influenced sense of self that enhances functioning, it may not be true that evolution specifically selected individuals who have a sense of self.

However, although each source of evidence pertaining to the evolutionary origins of the human self may not be definitive on its own, it is also the case that the available evidentiary sources strongly converge, favoring the evolutionary hypothesis. We illustrate this point by highlighting some of the converging evidence.

Getting a Grasp on the Self

Exactly what is this "self" that has been the object of so much theoretical speculation and empirical attention? One answer comes from a developmental perspective, which posits that the self develops gradually through a succession of behaviors. The ability to monitor and reflect on these behaviors, otherwise known as metacognition, is thought to be an indicator that an individual possesses a self-concept. For example, using reactions to a commonly used test for the self-concept, the "mirror test" (e.g., how one responds to one's own reflection in a mirror), Rochat (2003) proposed five levels of self-awareness. These are as follows:

Level 0: Confusion. At this level, there is no self-awareness. The person is unaware of any mirror reflection or the mirror itself. They seem to perceive the mirror as an extension of their environment.

Level 1: Differentiation. The individual realizes the mirror is able to reflect things. They understand that what is in the mirror is different from what is surrounding them. They differentiate between their own movement in the mirror and the movement of the surrounding environment.

Level 2: Situation. The individual can link the movements in the mirror to their body perceptions. This is the beginning of the realization that what is visualized in the mirror is special to the self.

Level 3: Identification. The individual can now see that what's in the mirror is not another person but actually him/herself. Thus, at this stage, instead of referring to the mirror while referring to him/herself, the individual refers to him/herself while looking in the mirror.

Level 4: Permanence. Once the individual reaches this level, they can identify the self beyond the present mirror imagery. The individual now experiences a "permanent self," and this is accompanied by the ability to identify the self in previous pictures as looking different or younger.

Level 5: Self-consciousness or "meta" self-awareness. Here, thinking is accompanied by the realization that the image in the mirror can be seen from a third person's view, and not just the first person perspective. The individual begins to understand that they can be "in the mind of others." For example, the individual may understand how they are seen by others.

However, such conceptions may focus unduly on metacognitions and self-reflection. The more researchers consider the activities and functions that are linked to the self, the more complex they find the answer to the question "what is the self" to be. For example, Klein and Lax (2010) noted seven types of self-knowledge.

1. Episodic memories of one's life events.
2. Semantic summary representations of one's personality traits.
3. Semantic knowledge of facts about one's life.
4. An experience of continuity through time: The "I" experienced now is connected to the "I" experienced at previous time points.
5. A sense of personal agency and ownership: The belief or experience that "I" (agency) am the cause of "my own" (ownership) thoughts and actions.
6. The ability to self-reflect: Forming meta-representations where the agent is the self and where the agent makes inferences on the basis of those representations.
7. The physical self: Represent and recognizing (e.g., in mirrors, photographs) one's body.

Some theorists have attempted to find an underlying organization to these different facets of self-knowledge. For example, one conception (Fingelkurts et al. 2016) suggests that the experiences of self incorporate three main contributors. One provides the first-person perspective and the sense of agency (the witnessing observer); the second provides the experience of self as a localized embodied entity, emotion-related thoughts, and autobiographical memories (representational-emotional agency); the third provides the experience of thinking about oneself, including momentary narrative thoughts (reflective agency). The theoretical conception has the additional advantage of grounding each of these contributors in brain structure and function. The conception suggests that selfhood involves the activation of a default mode network (DMN) that links neural activity in frontal-left, posterior-right, and posterior-left areas of the cerebral cortex. More specifically, the DMN is commonly viewed to include the left and right middle frontal gyri, bilateral frontal medial areas, left and right middle temporal and occipital gyri, and left and right precuneus. These are thought to be active and functionally synchronized during self-related tasks and when participants engage in self-generated thoughts.

On the Adaptive Functionality of the Self

The study of self-related brain functioning is only one source for the converging evidence pointing to the evolutionary origins of the self. One other clue to the natural selection of a characteristic lies in the characteristic's functionality. That, if the self is an adaptive trait for a species, a researcher ought to be able to document the ways in which the self is functional to the species. Parker (1997) has made exactly this evolutionarily driven self-functionality argument not only for humans but also for nonhumans, as well. We will consider the nonhuman angle of the self later. For now, we focus on the functionality of the self for humans.

As would be expected from an evolutionary standpoint, there is variability among individuals in terms of their ability to experience a self.

Clearly, when considering this variability, some forms of self-related thought are not adaptive for humans. Excessive focus on the self can produce maladaptive thinking and can impair task performance (Pinel and Bosson 2013). Moreover, an excess of "selfness," manifested in the form of narcissism, can similarly produce negative consequences (Sedikides and Campbell 2017).

However, when viewed from a broad perspective, the evidence also suggest that humans who have a well-formed self do better than those who do not. For example, the ability to experience a self may be diminished in persons with schizophrenic disorder (Molnar-Szakacs and Uddin 2016) and persons with autistic spectrum disorder (Lind 2010; Lyons and Fitzgerald 2013). Similarly, a person who experiences damage to, or an impairment of functioning in, their right hemisphere will sometimes suffer from depersonalization disorder, manifesting an altered, detached, or estranged sense of self (Kober et al. 2005). Moreover, while sometimes able to function adequately, those whose self-related memory (and thus, their sense of self) is diminished because of disease-induced or accident-induced brain damage exhibit impaired functioning in real-world contexts, including the social and/or occupational functions of daily life.

Theorists argue that this functionality is especially evident in the human social world (e.g., Humphrey 1986). Indeed, it may be the case that only species capable of self-reflection are able to use introspectively based social strategies and to experience socially grounded emotions, such as evaluative embarrassment, pride, shame, and guilt. Thus, reflecting on and understanding one's own behavior allows one to engage in sophisticated and nuanced social behavior. This is especially true when species members have a high degree of interdependence, as do humans. Both cooperation with, and competition against, other species members can be enhanced when one has the ability to reflect on the self and to anticipate one's own behavior as it relates to the behavior of others in various social contexts. Moreover, mental simulations that involve the self may be especially important for optimal selection of long-term goals and a reduction in the likelihood of failure.

Behavioral Evidence and Cognitive Evidence from Nonhuman Species Linking Evolution to the Self

Cross-species comparisons of behavioral characteristics and cognitive characteristics can also provide converging evidence pertaining to the thesis that the self is a product of evolution (Sedikides and Skowronski 1997). Evolution does not create something from nothing – it merely selects from what is already available. Thus, any given biologically based characteristic ought to be present in other species, though perhaps only in rudimentary form.

One such characteristic is self-recognition. It has long been known that chimpanzees are capable of recognizing as "self" their own image in a mirror. Subsequent investigations showed that this capacity is shared among other great apes (bonobos, gorillas, orangutans), and perhaps even among primates such as rhesus monkeys who are not as similar to humans as are the great apes. However, even some nonprimate animals seem to exhibit this capacity. The list includes dolphins, orcas, and the Eurasian magpie (for a cross-species overview, see Mitchell 2012).

This list may lengthen substantially in the near future. Recent thinking indicates that additional evidence of the presence of the self in nonhuman animals can be obtained by "tuning" self-tests to the species being tested. That is, many studies looking for evidence of animal self-concepts have used "the mirror test." This test seeks evidence that an animal somehow recognizes an image in a mirror as "them." The test, however, may not be diagnostic of the presence of a self-concept in animals that rely on nonvisual sensory systems. For example, studies conducted with dogs using olfactory cues instead of visual cues tentatively suggest that dogs may possess a self-concept.

Such cross-species diversity might have emerged because evolution often solves similar environmental problems in similar ways. Thus, if a nonhuman species occupies an environmental niche similar to the niche occupied by the species in the evolutionary line that led to the human species, then nonhuman species might be expected to exhibit characteristics similar to the

human species. For example, the hominid line has included relatively large-brained individuals whose food sources were widely dispersed in time and space. Similar descriptions can be applied to elephants and dolphins. Thus, the emergence of "the self" in all these species may not be coincidental but instead may reflect evolutionary convergence.

An additional indication of self-producing evolutionary convergence comes from the observation that many of the species that exhibit self-recognition also tend to be highly social. This observation suggests that self-recognition capacities may enhance individual functionality in a social context. This converges with the view that primate brains are "built to be social." Via evolution of the capacity for self, nature may have found a way to tune big-brained social organisms so that they be well suited to survival in environments that present difficulties in food procurement.

Pursuing a related line of thought, Hills and Butterfill (2015) proposed behavioral and biological commonalities between external foraging in space and internal foraging over environments specified by cognitive representations, and they explored the implications of these commonalities for understanding the origins of the self (for similar ideas, see Sedikides and Skowronski 1997). Hills and Butterfill suggest that one of these components is autonoetic consciousness, a term that refers to the ability to mentally place the self in the past, in the future, or in counterfactual situations. This capability allows one to examine one's own thoughts, a kind of self-consciousness that likely is a contributor to the self-multiplex.

Exploration of whether nonhuman species have autonoetic consciousness has concentrated on the seeming ability of nonhuman species to experience episodic memories. Episodic memories involve subjective event re-experiencing (including images, sights, smells, and feelings), as well as the knowledge that these events occurred in an earlier time. Lou et al. (2004) reasoned that autonoetic consciousness emerges via retrieval of episodic memories and that such retrieval affects conscious self-representation. This episodic memory capability would seem to be functional to the self. In the absence of the ability to recall experiences and reflect on them, humans would be stuck in a state of constant awakening, without a past and therefore unable to prepare for the future.

Accumulating evidence suggests that episodic memory (and, by extension, autonoetic consciousness) may not be unique to humans (but see Klein 2014). For example, research results show that animals can act as if they remember time. This tendency can be seen in species that are, in evolutionary terms, close to humans, including chimpanzees and bonobos, baboons, and rhesus monkeys. For example, in one study (Martin-Ordas et al. 2010), preferred perishable food (frozen juice) and less preferred but non-perishable food (grape) were hidden from primate subjects. The subjects could choose one of the foods either after 5 min or 1 h. The frozen juice was still available after 5 min, but melted after 1 h, becoming unobtainable. The primate subjects chose the frozen juice to a significantly greater extent after 5 min and the grape after 1 h, suggesting that they could remember how the passage of time affected the results of their foraging episodes. Similar findings have been reported for nonprimate species, including nonprimate mammals (rats, meadow voles, Yucatan minipigs, dogs) and birds (pigeons, black-capped chickadees, magpies).

Given these findings, that animal behavior can be sensitive to time is not in much doubt. At issue is whether an animals' ability to use time reflects the presence of an episodic memory system and/or autonoetic consciousness. Attempts to resolve this conundrum may come from neuroimaging and neuroanatomy studies. Results from such studies indicate that episodic memories in humans depend on the integrity of the hippocampus and related structures. This also seems to be the case for nonhuman species. For example, after encountering a sequence of five odors, the behavior of rats with hippocampal lesions was inconsistent with the idea that they could recall odor order. This insensitivity to order occurred despite the rats acting as if each odor was familiar (Eichenbaum 2013). Additional support comes from studies of monkeys with fornix lesions.

Such lesions disrupt the hippocampal system: lesioned monkeys were unable to make accurate recency judgments (Charles et al. 2004). In all, the probable presence of a time-sensitive episodic memory-like system in nonhuman species, as well as in humans, fits with the general thesis that the human self was formed as a result of evolutionary pressures.

One other indicator of the self is a sense of agency over one's actions: the subjective awareness that one is initiating, executing, and controlling one's volitional actions. This sense of agency is sometimes impaired in humans who have a disrupted self, such as those with schizophrenic disorder or autistic disorder (Molnar-Szakacs and Uddin 2016).

Do nonhuman species share this sense of agency? The answer seems to be "yes" (Moore 2016). For example, in one study (Kaneko and Tomonaga 2011), chimpanzees were presented with two cursors on a computer display. One cursor was manipulated by a chimpanzee using a trackball, whereas the other cursor displayed motion that had been produced previously by the same chimpanzee. Chimpanzees successfully identified that cursor they were able to control. Additional studies showed that at least one chimpanzee could monitor the movement that was theirs in both the temporal dimension and the spatial dimension. Such understanding of agency may also extend beyond the primate line (e.g., to dolphins).

We speculate that this sense of agency may (at least partially) be rooted in the mirror neuron system. Although this system has been implicated in one's ability to mimic others, it also seems to be involved in the monitoring of self-movements, which may contribute to the sense of agency (Maeda et al. 2015). Interestingly, the mirror neuron system may, in evolutionary terms, be relatively old, given that it is shared with other species, such as birds (Prather and Mooney 2015). This may represent another example of how evolution co-opts existing traits. The mirror neuron system, which likely evolved to facilitate social learning, may have been shaped by evolutionary pressure to be a contributor to an individual's sense of self.

For How Long Has the Human Species Possessed a Self?

The possibility that the self (or at least components of the self) can be shared across species suggests that "selfness" (or at least some components of the self) ought to be present in early humans, or even in the hominid species that may have predated humans. Evidence relevant to this point can be examined by looking at the things that the human species have left behind over time.

Using such evidence, early views of the self's emergence in humans noted that evidence of human "selfness" was in place for humans who lived as early as 50,000 years ago (Leary and Buttermore 2003). The evidence for such a date was relatively ample and included the presence of artistic figurines, bow-and-arrow technology, and personal ornamentation. The evidence also indicated that humans were performing ritualized burials. However, recent artifacts (Hublin et al. 2017) have pushed this "selfness" date back substantially, even to as long as 300,000 years ago. For example, recovered beads, likely used for personal adornment, dated to about 100,000 years ago. Other finds indicate that ochre, a color often associated with bodily adornment, was used by hominid species about 164,000 years ago. Some evidence even suggests that the capacity for self predates the human species: A carving of the head and torso of a woman attributed to *Homo heidelbergensis* has been dated to at least 250,000 years ago.

Evidence Linking Brains, Genes, and the Self

A substantial corpus of research has explored whether self-related thought is linked to specific areas of the brain. Reviews of the work that explores self-related thought (Northoff 2013) lead to clear results. A set of brain regions collectively referred to as the cortical midline structures (CMS) show a special significance in self-related thought. Studies looking at neural activity levels demonstrate that stimuli that are personally relevant (vs. not) to individuals induce higher neural

activity in several CMS regions. Such patterns emerged across stimuli, including faces, trait adjectives, movements/actions, memories, and social communication. The implicated CMS regions include the perigenual anterior cingulate cortex (PACC), the ventromedial and dorsomedial prefrontal cortex (VMPFC, DMPFC), the supragenual anterior cingulate cortex (SACC), the posterior cingulate cortex (PCC), and the precuneus.

Interestingly, some of these areas also may be implicated when thinking about others. Such areas include the midline regions, the dorsomedial prefrontal cortex, and the posterior cingulate cortex. This result points to an intrinsically social dimension in the human neural activity, which may be essential for any subsequent consciousness of both one's own self and other selves.

However, this focus on self-referential thought may not capture all kinds of self-related thought. As noted earlier, there may be different facets of "selfness," and these facets may be related to distinct brain areas. One approach to this multifaceted self (Fingelkurts et al. 2016) links the experience of selfhood to the activation of a default mode network (DMN). This network interconnects neural activity in frontal-left, posterior-right, and posterior-left areas of the cerebral cortex. Specific areas implicated are the left and right middle frontal gyri, bilateral frontal medial areas, left and right middle temporal and occipital gyri, and left and right precuneus. These are active and functionally synchronized during self-related tasks and when participants engage self-generated thoughts. The frontal-left structures are linked to the first-person perspective and the sense of agency (the witnessing observer). The posterior-right areas are linked to the experience of self as a localized embodied entity, emotion-related thoughts, and autobiographical memories (representational-emotional agency). The posterior-left areas are linked to the experience of thinking about oneself, including momentary narrative thoughts (reflective agency).

Research in anthropology and comparative biology indicates that the self is associated not with physical elements of the brain, but also with elements of the human genome. These lines of research culminate to the conclusion that the modern human mind is a mosaic of traits inherited from a common ancestry with close relatives (Sherwood et al. 2008). Indeed, the human brain is generally organized in a fashion similar to that of other primate species, and the greater the relation of those nonhuman species to humans, the more similar the organization. For example, the planum temporale, a surface feature of the cerebral cortex in the region of Wernicke's area, displays left hemisphere dominance in humans, bonobos, chimpanzees, gorillas, and orangutans.

However, human brains also have been enhanced via evolutionary specializations within particular domains. These include cognitive adaptations and linguistic adaptations that are correlated with enlargement of the neocortex and related structures. Several anatomical and molecular changes have occurred that seemingly reflect the modern human brain's high metabolic demand and enhanced synaptic plasticity. Illustrating this point, in humans higher-order unimodal and multimodal cortical areas have grown disproportionately relative to primary cortical areas. Moreover, in comparisons of the brains of higher-order primate and the brains of humans, only humans have multiregion lateralized networks, which provide frontoparietal connectivity. Sherwood et al. (2008) maintain that this pattern of within-hemisphere connectivity distinguishes human brains from the brains of nonhuman primates.

Hominid DNA evidence leads to similar conclusions. Researchers have recently reproduced a complete genomic sequence of a Neanderthal woman (Prüfer et al. 2015). Only a small list of simple DNA sequence differences distinguished these Neanderthals from modern humans. A good deal of these differences implicated the biology of the neocortex, a finding that is consistent with the idea that evolution prompted the emergence of the modern human self.

A similar conclusion can be derived from studies that examine the brain structure alterations linked to various psychopathologies in which symptoms include alterations in the sense of self (Northoff 2014). Four of the most studied disorders involve self-distortions are schizophrenia, autism spectrum disorder, major depression, and borderline personality disorder. The relevant

evidence indicates that distortions of the sense of self in these psychological disorders are associated with alterations in the brain's cortical midline system (including the perigenual anterior cingulate, inferior frontal gyrus, and insula), mirror neuron system (including the frontoparietal region [precentral gyrus, precuneus, supramarginal gyrus, inferior parietal lobule] and limbic system [anterior insula and anterior mesial frontal cortex]).

Additional findings link dysfunctions of the self to genetics. For example, Won et al. (2016) explored activity in regulatory regions of genes on the human genome that may be related to schizophrenia. These regions work like rheostats, increasing or decreasing a target gene's activities. Such rheostat-like loci regulate the activity of genes that are known to be crucial to brain development and that are very active early in brain development. It follows that disorders such as schizophrenia – and, by extension, the self-distortions that are symptomatic of schizophrenia – may have a similar basis in the genetics that control brain development.

Researchers also have compared the genetics of nonhuman primate species to the human genome in order to gain insight into brain alterations that may have occurred during evolution. Relevant studies have examined corticogenesis (the process in which the cortex of the brain is created during neurodevelopment), and again have focused on those gene regions that regulate the expression of genes. Consistent with an evolutionary perspective, Reilly et al. (2015) concluded that many human lineage changes reflect alterations in gene regulation. That is, these alterations operate within older regulatory mechanisms and evolutionary processes essential for building the mammalian cortex, but they appear in modified form in humans. Saphire-Bernstein et al. (2011) forged a link among elements of the self, the brain, and genetics. They reported that varying genetic forms of the oxytocin receptor are associated with varying levels of self-esteem and depression.

There is a long way to go when trying to understand how evolution may have produced physical alterations in the brain and the human genome that link to the human experience of self. Nevertheless, the steady stream of results has taken substantial steps toward establishing the anatomical and genetic underpinnings of the self.

Conclusion

Psychologists have long had a fascination with the concept of "the self." One thread of research into this topic has explored the possibility that any or all of the various facets of self-related thought have been promoted in humans by natural selection. Evidence favoring this idea comes from disparate sources. These include studies of archeology, cross-species studies of biology, psychology, and behavior, studies of anatomy and genetics, and studies of brain action and neural function. Individually, none of these sources is sufficient to establish unambiguously that the human self has emerged as a product of natural selection. However, the evidentiary converge provides strong support for this thesis.

Cross-References

- ▶ Brain Changes
- ▶ Brain Development
- ▶ Brain Imaging
- ▶ Brain Lesion Studies
- ▶ Brain Size Growth in Humans and Nonhuman Primates
- ▶ Burials
- ▶ Byproduct of Adaptations
- ▶ Cognitive Development in Non-Human Primates
- ▶ Convergent Evolution of Intelligence
- ▶ Development of Adaptations
- ▶ Dewall's (1982) Chimpanzees
- ▶ Environmental Unpredictability and Brain Complexity
- ▶ Episodic Memory
- ▶ Evolution and Self-Awareness
- ▶ Evolution of Adaptations
- ▶ Evolution of Memory
- ▶ Evolution of The Brain, The
- ▶ Evolutionary Perspective, The
- ▶ Mindblindness
- ▶ Narcissism
- ▶ Naturalistic Fallacy, The

- Selection for Cooperative Relationships
- Selection of Phenotypes
- Selection Pressure
- Self-Assessment of Fighting Ability
- Self-Concept;
- Self-Definition
- Self-Esteem and Social Status
- Self-Esteem as a Status-Tracking Mechanism
- Self-Esteem Guides Decisions About Who to Challenge
- Self-Esteem Reflects Assessments of Valuation
- Self-Esteem Tracks Social Evaluation
- Self-Observation
- Theory of Mind
- Theory of Reciprocal Altruism
- Tit for Tat

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