



Human mnesic performance in a survival scenario: the application of the adaptive memory concept in ethnobiology

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ABSTRACT

Evolutionary psychologists suggest that the human brain has evolved to retain information of greater adaptive value in a differentiated manner, being this information relevant for survival. These premises are part of a research field defined as adaptive memory. This article reviews the main studies related to adaptive memory, indicating its recent findings, as well as discussing the possible applications of the theme to studies in evolutionary ethnobiology.

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INTRODUCTION

A set of evidences suggests that our mind has been built to retain primarily specific information relevant to survival and reproduction (Nairne et al. 2007, 2008; Nairne and Pandeirada 2008). In this way the human mind was designed by natural selection to respond to different inputs of

information by virtue of its evolutionary meaning (Tooby and Cosmides 2005).

The perspective of evolutionary psychology has influenced researches that seek to understand the evolution of the human mind. According to Nairne et al. (2008), the inclination of our memory systems to retain important information from the adaptive point of view was of the utmost

importance for our ancestors to learn and remember feeding sites, predators actions, and partner behaviors (e.g. Nairne and Pandeirada 2008). Thus, adaptive memory studies challenge conventional memory research, which focuses on the immediate mechanisms that guide mnemonic phenomena (Nairne *et al.* 2007), rather than looking for mechanisms that lead to biases in recalling information.

The present review addresses the idea of adaptive memory, presenting the most recent findings and discussing research opportunities and challenges within the field of evolutionary ethnobiology.

Adaptive memory

The term adaptive memory was proposed by Nairne *et al.* (2007) to describe the performance of the human mind in a context of survival, suggesting that our memory systems evolved through natural selection to recall adaptive information.

Although in practice it is not easy to test this hypothesis, the effects of survival on the human mind has been consistently debated in an emerging set of studies (see Nairne *et al.* 2007, 2008, 2009, 2012, Nairne and Pandeirada 2008, Nairne 2010, Yang *et al.* 2014) that investigated how words or drawings are remembered, so that such words or drawings had different survival values. In many of these studies, participants involved in the research initially classified a set of words or images provided by the researcher, according to their importance for survival. Then, a recall test was performed (see, for example, Nairne *et al.* 2007, 2012, Yang *et al.* 2014).

The results of many of these studies support the idea of memory biases associated with adaptive importance. Nairne *et al.* (2007), when studying memorization of

words, observed that there was a tendency for words valued as important for survival to be remembered more than words considered less relevant to survival.

Another aspect of adaptive memory studies has been to compare different scenarios regarding the memorization of elements. In this sense, volunteers are asked to imagine that they are in different contexts, such as in places without basic survival materials, and in less critical scenarios, such as participating in games or moving to another location (Nairne *et al.* 2007, 2012). Thus, stimuli such as words or images are presented to volunteers after they are invited to imagine themselves in one of the indicated scenarios. It has been observed that the context of survival (e.g. finding water and food or finding protection against predators) generates higher levels of retention of words in memory when compared with other contexts (Aslan and Bauml 2012, Nairne *et al.* 2007, 2008, 2009).

Studies implemented with other non-word stimuli have also obtained similar results. Nairne *et al.* (2012), for example, presented to the volunteers graphical stimuli with the localization of food (fruits and game animals) in different scenarios. Part of the volunteers should have imagined that they were in a strange location with no basic resources for survival - a survival scenario - and the other part should have imagined that they were in a hunting competition. The authors observed that people tended to best remember the location of items when they were described in a survival scenario.

Some studies have also attempted to investigate the effect of the context of survival on memory retention in children. In some of these cases, the same memory biases that privileged information of adaptive relevance were found in very different

contexts from the environmental and cultural point of view. Barrett and Broesch (2012), for example, when studying memorization of dangerous and non-dangerous animals, found that children living in the city of Los Angeles in California and children of a village in Shuar in the Ecuadorian Amazon obtained a higher mnemonic performance when images and information on the name and diet of dangerous animals were presented.

Although the trend of greater retention of adaptive information is found in different age ranges, studies have found that the magnitude of these memory biases is higher in children and tends to decrease with increasing age. Barret and Broesch (2012), for example, found this tendency by studying memorization of information on animals (in the 'dangerous but not poisonous', 'dangerous and poisonous', 'not dangerous, but poisonous' and 'neither dangerous nor poisonous' groups) in three villages on the islands of Fiji.

Adaptive memory hierarchy

In a study to test human attention to threats, it has been observed that non-evolutionary threats (such as firearms and cars) also attract and maintain attention in the same way as would be expected for evolutionary threats (such as snakes and spiders) (Young *et al.* 2012). This indicates that attention is not only attracted by evolutionary threats, which suggests the presence of more general cognitive processing¹ (see Bolhuis *et al.* 2011, Young *et al.* 2012). Thus, the bases for the survival effect have been debated, and specific domains² may not be the only explanation for the effect of survival processing on human memory (Palmore *et al.* 2012).

Another key issue in adaptive memory

studies is that other mechanisms - not just survival - contribute to the fitness of organisms, such as partner selection, incest avoidance, among others. Thus, it would be expected that all scenarios with adaptive mechanisms would lead to a mnemonic advantage. However, this was not found in a study developed by Sandry *et al.* (2013). The authors studied the memorization of words in different scenarios related to adaptive mechanisms (survival, fear and phobia, partners selection, incest avoidance, detection of cheaters, jealousy, infidelity and gaining or maintaining status) and observed that the survival scenario excelled in comparison to all the others as to the memorization of words.

These results indicate that although the survival scenario presents higher levels of memory retention, other processes also receive human attention and obtain significant retention. Thus, it is likely that memory is sensitive to processing of information of adaptive relevance at a hierarchical level, and consequently, some adaptive mechanisms have closer links with memory systems than other adaptive mechanisms (Sandry *et al.* 2013).

Tse and Altarriba (2010) tested the achievement of survival in human memory from explicit memory (retention and conscious recall of previous episodes), and implicit memory (retention and unintentional recall of previously acquired information), and found that during the explicit memory test in which there was intention to retrieve information (e.g. retrieving a "word"), there was a greater retention and retrieval of information related to survival. However, in the implicit memory test in which an intentionality of recovery was not demanded (e.g. write the first word that comes to mind), the retention and retrieval of this type of information was not observed. The authors

argue that perhaps our memory system is flexible and adaptable, and there is no intentionality to retain and retrieve adaptive information. Thus, the proposition of a memory hierarchy proposed by Sandry *et al.* (2013) that generates the decrease in the retention of adaptive information when people are exposed to different survival scenarios may be associated with the human non-intentionality to preferably retain this type of information.

According to Tse and Altarriba (2010) this survival mnemonic advantage may only be reflecting an adaptive bias that is activated when people classify words into a survival scenario (Tse and Altarriba 2010). In a study by Yang *et al.* (2014) it was found that the survival effect was well preserved in the memory of young and old people in ancestral survival scenarios (pasture) and non-ancestral (modern survival scenario "mountains"), suggesting that this effect emerges in childhood and is reflected in adult individuals. These findings indicate that human memory may be flexible to process information related to survival in both ancestral and non-ancestral scenarios, thus demonstrating an "ancestral non-priority" associated with retention and retrieval of adaptive information, which is distinct from what is proposed by evolutionary psychology.

Implications of the adaptive memory scenario for ethnobiological studies

An interesting question that may derive from the idea of adaptive memory involves the understanding of how memory biases can affect the interactions between people and the environment. For example, in social-ecological systems, certain environmental resources present more popularity than others and this may reflect a differential

selection of resources that offer benefits to human groups (Ferreira Júnior and Albuquerque 2015). In medicinal use, in particular, a set of plant characteristics may be targeted by human groups in the indication of a medicinal plant.

Thus, considering that multiple variables have already been associated with the popularity of medicinal plants in local medical systems, such as efficacy, availability, taste, aroma and others (Casagrande 2000, Medeiros *et al.* 2015), we can hypothesize that the adaptive importance of such plants is the result of a balance between these characteristics. For example, a plant that is highly efficient to treat a certain disease, but extremely difficult to find, may confer less adaptive advantage than a slightly less efficient plant, but of high availability (and vice versa).

In this sense, from the idea of adaptive memory, the most popular plants in medicinal use may be more easily remembered and transmitted in a given human group, since they present important characteristics for the treatment of diseases, which confers greater adaptability to the environment (Ferreira Júnior and Albuquerque 2015).

Selecting a medicinal resource from a cost-benefit assessment within a local medical system can lead to cognitive biases that make information about this resource more memorable. In practical terms, a set of adaptive information allows a greater adaptation of people to their environment, increasing their chances of survival.

According to Nairne (2010), additional evidence on the evolution of the human mind to recall information of adaptive relevance can be obtained from cultural transmission studies in the quest to understand what kinds of information are most likely to be transferred from person to person and

among generations. For example, Soldati *et al.* (2015) verified that medicinal plants learned from parents receive priority during social transmission, and childhood is the most significant learning stage. Another study carried out in rural communities of the Caatinga of the Northeast of Brazil observed that people remembered information about food species consumed during periods of food shortage (Nascimento *et al.* 2012). These data may support the fact that human memory is equipped to retain adaptive information from childhood.

In this context, the ability to recall information of adaptive relevance proves to be extremely important for the adaptive success of our species. The formation of a social brain capable of solving complex problems that emerged in the evolutionary past culminated in the direction of this information through social transmission. If this is the case, then one can expect that the knowledge of plants and animals that group characteristics relevant to survival tends to be more often transmitted than the knowledge of resources that do not group these characteristics in a given human group.

Some challenges, however, are evident in the study of the adaptive memory associated to social-ecological systems, especially in the selection of medicinal plants. We are based on the hypothesis that popular species in medical systems are recalled and transmitted differently because they are information of greater adaptive importance. However, such a hypothesis is difficult to test, since the adaptive importance of medicinal plants can not be easily obtained without falling into simplicity.

As an example, the measurement of the efficiency of medicinal plants is evaluated through its pharmacological potential. Such evaluation, based only on chemical efficacy, may neglect the fact that plants without any

specific bioactive compounds to treat a certain disease may have a great contribution to healing. For example, the symbolic importance of a plant can be so great that its use in healing rituals can lead to psychological and physiological responses that contribute to the improvement of the individual's health, in what Moerman (2002) names 'a response to the meaning'.

Thus, some issues that should be addressed in future studies include (a) the identification of information of greater adaptive relevance and the aspects that amplify this relevance; (b) information regarding the treatment of serious diseases or frequent illnesses is more likely to be transmitted between individuals.

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