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Brief article

Adaptive memory: Young children show enhanced retention of fitness-related information

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ABSTRACT

Evolutionary psychologists propose that human cognition evolved through natural selection to solve adaptive problems related to survival and reproduction, with its ultimate function being the enhancement of reproductive fitness. Following this proposal and the evolutionary-developmental view that ancestral selection pressures operated not only on reproductive adults, but also on pre-reproductive children, the present study examined whether young children show superior memory for information that is processed in terms of its survival value. In two experiments, we found such survival processing to enhance retention in 4- to 10-year-old children, relative to various control conditions that also required deep, meaningful processing but were not related to survival. These results suggest that, already in very young children, survival processing is a special and extraordinarily effective form of memory encoding. The results support the functional-evolutionary proposal that young children's memory is "tuned" to process and retain fitness-related information.

1. Introduction

Memory research has traditionally focused more on the *whats* and *hows* of human memory (i.e., its structure and proximate mechanisms) than on the question of *why* memory operates exactly the way it does (i.e., its ultimate function). A notable exception is a recent research program conducted by Nairne and colleagues (for an overview, see Nairne, 2010). Approaching memory from a functional-evolutionary perspective, these authors argued that human memory evolved to solve adaptive problems related to survival and reproduction, with its ultimate function being the enhancement of reproductive fitness. In particular, Nairne and colleagues hypothesized that, as a result of ancestral selection pressures, human memory should be specifically "tuned" to process and retain fitness-related information, i.e., information that helped our forefathers deal with recurrent ancestral requirements such as capturing prey, evading predators, avoiding toxic plants and animals, or finding the location of food and water.

Nairne, Thompson, and Pandeirada (2007) tested this hypothesis using the *survival-processing task*. In this incidental-learning task, participants are asked to imagine themselves being stranded in the grasslands of a foreign land where they would have to secure food and water and protect themselves from predators. Processing words in terms of their survival value in this imagined scenario enhanced participants' retention relative to other deep encoding procedures, such as rating (the same) words for pleasantness or relevance to moving to a foreign land, which is consistent with the functional-evolutionary view on memory. Extending the finding, Nairne, Pandeirada, and Thompson (2008) compared survival processing with the "who is who" of powerful encoding procedures, including pleasantness rating, self-referential processing, and intentional learning. Again, survival processing produced the highest levels of retention (see also Kang, McDermott, & Cohen, 2008; Weinstein, Bugg, & Roediger, 2008).

Like evolutionary psychology in general, research on survival processing has focused on adult participants.

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However, if humans have an evolved bias to remember fitness-related information particularly well, this bias might be present already early in life. Indeed, evolutionary developmental psychologists emphasize that ancestral selection pressures operated not only on reproductive adults, but also on pre-reproductive children (e.g., Bjorklund & Pellegrini, 2000; Volk & Atkinson, 2008). The proposal is that our ancestors had to survive their pre-reproductive ontogenetic stages before becoming sexually mature adults, and thus, any inborn or early-developing feature of the cognitive system that promoted survival early in life should have conferred a (delayed) reproductive advantage and been favored by natural selection. Specifically, (ancestral) children showing a bias towards preferential remembering of fitness-related information should have been more likely to survive into adulthood, reproduce, and pass along their genetic record, than children not showing such bias.

Adopting a functional-evolutionary perspective, the present study explored the developmental origins of adaptive memory, examining whether young children show enhanced retention of fitness-related information. In two experiments, kindergartners, and younger and older elementary school children rated the relevance of random words to a fictive survival scenario and, later, received a surprise recognition test on the rated items. Recognition performance in the survival condition was compared to performance in various control conditions. If children's memory is "tuned" to process and retain fitness-related information, in both experiments, survival processing should produce the highest levels of retention. Finding a survival-processing advantage in young children who should have only limited knowledge about or experience with survival-related situations would provide particularly strong evidence for a deeply rooted, evolved adaptation in human memory.

The inclusion of pre-school children into our study also permits to examine whether the memorial advantage of survival processing may be due to more basic memory processes, like enhanced elaborative processing (Kroneisen & Erdfelder, in press), rather than being due to the fitness-relevance of the employed scenario. Pre-school children are often considered "nonstrategic rememberers", typically showing reduced elaboration in memory tasks, compared to older (school-aged) children (Ornstein, Haden, & San Souci, 2008). Thus, if the survival-processing advantage reflects enhanced elaboration, the advantage might be present in older (school-aged) children, but be reduced or eliminated in younger (pre-school) children. In contrast, if it is the fitness-relevance of the survival scenario that matters, one might expect the survival-processing advantage to be present even in young, "nonstrategic" kindergartners. To date, there is only one study that applied the survival-processing task to a children sample. Otgaar and Smeets (2010) found improved memory in the survival condition compared to a pleasantness and a moving control condition in 8- and 11-year-old school children.[1] Including "nonstrategic" kindergartners, the present study goes beyond this prior work, thus providing a particularly strong test of the view that the memorial advantage in the survival-processing task is due to the fitness-relevance of the employed task.

2. Experiment 1

Experiment 1 examined the memorial effects of survival processing in 4- to 10-year-old children, using *pleasantness-rating* and *word-length rating* as control tasks. Pleasantness rating represents a standard deep (semantic) encoding procedure known to produce exceptionally high levels of retention (e.g., Packman & Battig, 1978). Word-length rating represents phonemic processing, typically leading to more shallow encoding and thus to comparatively poorer retention (e.g., Gardiner, Brandt, Vargha-Khadem, Baddeley, & Mishkin, 2006). The word-length condition was included as a baseline for the pleasantness condition to rule out that any observed advantage of survival processing over pleasantness rating was due to the latter's failure to improve memory in young children (e.g., Ghatala & Levin, 1982).

2.1. Method

2.1.1. Participants

Twenty-four kindergartners (4–6 years; $M = 5.4$), 24 younger (7–8 years; $M = 7.5$), and 24 older (9–10 years; $M = 9.4$) elementary school children participated in the experiment.

2.1.2. Materials

The item pool consisted of 120 concrete nouns drawn from a German norm for children (Hager & Hasselhorn, 1994). Half of the items served as to-be-rated target words, the other half served as distractor words in the recognition test. The 60 target words were randomly divided into three lists of 20 items.

2.1.3. Design and procedure

The experiment consisted of an initial rating phase, a distractor phase, and an unexpected test phase. In the rating phase, the 60 target words were presented auditorily at a 5-s rate by the experimenter. The 20 items of a list were presented in succession, each list preceded by one of the following three instructions (corresponding to three different encoding conditions):

2.1.3.1. Survival condition. I would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. You are hungry and thirsty, and you have to protect yourself from wild animals. I am going to read you a series of things now, and I would like you to tell me whether these things would be useful for you in this survival situation.

2.1.3.2. Pleasantness condition. I am going to read you a series of things now, and I would like you to tell me whether you find these things pleasant.

[1] Otgaar and Smeets (2010) did not examine whether the size of the survival-processing advantage differed across age groups.