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The Development of Adaptive Memory During Childhood

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Abstract

In this chapter we explore the development of adaptive memory during childhood. The survival processing advantage is said to enhance learning and memory because evolution has led to the prioritization of the retention of fitness-relevant information. However, various studies have demonstrated that survival processing involves elaborate, distinctive, relational, and self-referential encoding, which can predict the memorial advantage of survival processing and other adaptive memory benefits. Furthermore, research suggests that these effects are consistent across development, indicating that fitness-relevant survival processing is observable even very early in children's memory. Throughout the chapter we examine how fitness-relevant information processing engages multiple cognitive processes simultaneously, leading to mnemonic advantages. These processes begin to develop early in childhood and can be observed in various contexts. We review the position that although our current memory system is the result of evolutionary pressures, it is not essential for an evolutionary hypothesis of memory to consider the survival-processing advantage as a distinct component of adaptive memory that remains invariant across development. We conclude by emphasizing the need for further scientific investigation to understand the functional properties of memory, including both the role of proximate mechanisms in adaptive memory in general and survival processing specifically. Although research in this area has started, there is still much to be discovered about the development of these mechanisms and their relevance to changes in our adaptive memory systems.

There can be no debate that a functioning memory system is adaptive to an organism. Our memory is especially engineered to encode, store, and remember information that helps us interpret the present and anticipate the future (e.g., see Howe & Otgaar, 2013). Our memories are well adapted for the environments in which we have evolved to ensure survival. Recent research suggests that adaptations of our memory systems prioritize the processing of information relevant to our survival. That is, scholars have argued that we focus on survival-related information because of its greater adaptive significance (see Nairne, 2010). What we remember depends on what we attend to and how we encode, store, and retrieve information; and some information is more important to attend to and remember than others. From an evolutionary perspective, it is adaptive to be attentive to stimuli that can enhance our chances of survival or that can cause harm and endanger our chances of survival (Sellers & Bjorklund, 2014).

A question that is important to theories of adaptive memory is that if indeed a behavior is adaptive, it should be present in children (Bjorklund & Pelligrini, 2000; Volk & Atkinson, 2008). However, what is often overlooked in evolutionary accounts of adaptive behavior is that most adaptations *develop* over time. Although there are behaviors that are considered adaptive that do appear early in life, there are many others that do not appear in very young children. For example, it is considered by some that newborn's imitation of facial gestures (e.g., Meltzoff & Moore, 1985) is an adaptive behavior (e.g., Bjorklund, 1987). However, there are also many adaptations such as bipedal locomotion (approximately one year after birth), language (during the second year of life), and secondary sex characteristics (during puberty) that are not present in very young children. What this suggests is that a behavior or characteristic's emergence does not determine whether a particular behavior or characteristic is or is not adaptive but rather the emergence of it, if it is adaptive, is guaranteed during the life of an organism.

That our memory system has been shaped by evolutionary pressure is not in question. In this chapter, we consider the assumption that biases that have evolved to retain survival-related information may emerge later rather than early in development. Researchers have suggested that particular developmental events have to occur prior to the appearance of the adaptive behavior. For example, Howe and Otgaar (2013) argued that the survival processing advantage may not develop until people have sufficient experience with, and knowledge of, survival-relevant situations. That is, the development of survival processing effects may not be the result of the early emergence of a fitness-relevant memory system, but rather, occur in the context of principles that guide memory development more generally. For example, distinctiveness (ability to discriminate features in stimuli), item (recognizing specific item features) and relational (recognizing shared features) processing, and self-referential (information relevant to self) processing are mechanisms that emerge early in memory development and become developmentally invariant across childhood (Howe, 2011). It can be argued that these memory principles underlie the survival-processing advantage and are the tools of memory which account for adaptive memory effects and not the storage of fitness-relevant information in a memory system per se.

Although much survival- and fitness-relevant information is distinctive and well elaborated in memory, the mnemonic advantage of such information may simply be a by-product of these more general memory principles. In this chapter, we will first review the literature that has examined survival-memory advantages in children and then consider the explanation regarding the development of adaptive memory alongside other memory processes as children mature into adulthood. We will see that the following studies suggest that, even early in development, memory is especially sensitive for processing and retaining fitness-relevant information. The ontological question about the onset of fitness-related mnemonic advantages will be discussed.

Survival-processing Effects

The survival processing advantage was first demonstrated by Nairne et al. (2007), and the question of whether memory is also tuned for survival-relevant information early in ontogeny was considered by Otgaar and Smeets (2010). In a typical survival processing paradigm, participants are asked to rate words in relation to their relevance to one of three scenarios:

Survival. In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this survival situation. Some of the words may be relevant and others may not—it's up to you to decide.

Moving. In this task, we would like you to imagine that you are planning to move to a new home in a foreign land. Over the next few months, you'll need to locate and purchase a new home and transport your belongings. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in accomplishing this task. Some of the words may be relevant and others may not—it's up to you to decide.

Pleasantness. In this task, we are going to show you a list of words, and we would like you to rate the pleasantness of each word. Some of the words may be pleasant and others may not—it's up to you to decide.

Processing information in terms of its survival value leads to enhanced retention relative to several deep processing control conditions: specifically, rating items for pleasantness and relevance to a moving scenario (Nairne et al., 2007). Otgaar and Smeets (2010) adapted the survival processing task

using the Deese/Roediger-McDermott (DRM) paradigm. Specifically, participants were presented with semantically associated word lists (e.g., *bed*, *snooze*, *dream*) that converged on one non-presented critical lure (i.e., *sleep*). Young adults and children, aged 8-11 years old, were asked to make judgements about the relevance of each word on the list in relation to the scenarios taken from Nairne et al. This was followed by a recall task. In the DRM paradigm, falsely recalling the critical lure item from each list is used as an indication that the list lure was internally activated at encoding and incorrectly remembered. Otgaar and Smeets showed that all age groups evinced a survival processing effect replicating earlier research with adults. Interestingly, all participants also had higher levels of false recall in the Survival condition than in the other two conditions.

Aslan and Bauml (2012) used a modified version of the survival processing paradigm, comparing recognition performance on adaptive or non-adaptive processing tasks in young children. They aimed to match the survival condition in terms of schematic and self-referential processing by using two control conditions that used both types of processing, conditions likely to be more familiar to young children. Three age groups were tested: 4- to 6-year-olds, 7- to 8-year-olds, and 9- to 10-year-olds. Recognition was tested following processing of words related to the survival condition and two self-referential conditions:

Overnight condition. I would like you to imagine that you are packing your bag for an overnight stay at your best friend's home. I am going to read you a series of things now, and I would like you to tell me whether these things may be useful for your overnight stay.

Forgotten condition. I would like you to imagine that your parents have forgotten to pick you up from school/kindergarten, and you are all alone in front of the entrance. You are hungry and thirsty, and you are also a bit scared. I am going to read you a series of things now, and I would like you to tell me whether these things may be useful for you in this unpleasant situation.

Although recognition performance was poorest overall in the youngest age group, survival processing improved recognition performance relative to the control conditions for all ages. Thus, even for very young children, survival processing seems to be an effective form of memory encoding.

Similar findings have been obtained with variations in stimuli and procedures. A study by Otgaar et al. (2014) investigated the survival advantage for pictures. Young adults and children aged 7/8 and 11/12 were shown pictures that were negative, neutral, or survival related in nature, and asked to rate these pictures for relevance to the survival, moving, and pleasantness scenarios. They found a survival processing advantage in all age groups, but it differed as a function of stimulus type. That is, for the adults, a survival processing advantage was detected for the survival pictures. For the 11/12-year-olds, a survival processing advantage was found for the negative pictures, while for the 7/8-year old children, neutral pictures displayed a survival processing advantage. In a final experiment, Otgaar et al. (2014) used a short survival scenario in addition to the standard survival condition based on the suggestion that the original survival scenario was more elaborate than the comparison control conditions. The shortened version included only one problem:

Survival-short: "In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land. After searching along the surrounding area and the debris flushed to the shore, you are bound to realize that you have a major problem of survival: you have no potable waters. We are going to show you a list of words, and we would like you to rate how relevant each word would be in this survival condition. Some of the words may be relevant and others not and it's up to you to decide."

Otgaar et al. (2014) found that all age groups had significantly higher true memory rates in the survival compared to pleasantness scenarios, with no differences between the short and long survival conditions. These studies and other similar ones (see Aslan & Bauml, 2012) demonstrate that, even early

in development, memory can be capable of processing and retaining fitness-relevant information. However, this may have less to do with a predisposition to favor the processing of survival-relevant information and more to do with the greater likelihood of engaging various proximate mechanisms (e.g., elaboration, distinctiveness) in these tasks. Importantly, these proximate memory mechanisms are developmentally invariant, suggesting that the variables that mediate the adaptive memory effect are present early in childhood.

Survival-information Effect

Not only does survival processing yield mnemonic benefits, but survival information itself enjoys similar mnemonic advantages (Howe & Derbish, 2010). That is, stimuli that are survival related are better remembered than more neutral stimuli, or even stimuli matched for arousal and valence (Howe & Derbish, 2010). These benefits are thought to arise because human (as well as some nonhuman animals) memory systems have evolved to prioritize survival-related information over other information due to its greater adaptive significance.

Survival-linked stimuli also show a memorial advantage in children. Indeed, such early childhood adaptative mnemonic advantages have been shown for different stimuli and paradigms. In Otgaar et al.'s (2014) study, 11-year-olds and adults were presented with neutral (e.g., climber, hill, hike; critical lure: mountain), negative (e.g., blues, depressed, grief; critical lure: sad) and survival (e.g., disease, fever, flu; critical lure: sick) related DRM word lists. Similar to Howe and Derbish (2010), they found that for children, like adults, both true and false recall rates were higher for survival related lists compared to negative and neutral lists. They argued that this was strong evidence of developmental invariance. Memory prefers the retention of survival material and the development of memory illusions for survival-related material. Because of the relational nature of the DRM word lists, false memories were more easily elicited for the survival word lists relative to other word lists. That is, survival relevant stimuli

increased relational and elaborative processing since survival word lists were more associatively rich than the other lists. In the following sections, we will discuss potential underlying mechanisms within the survival-information-effect and how animacy and emotion may contribute to the mnemonic advantage of survival information.

Animacy-related Information. Evolutionary psychologists have proposed that human cognition is tuned to process animate, as opposed to inanimate, entities for fitness relevance purposes. Our ability to interact appropriately with animate bodies, dangerous or otherwise, has direct consequences on survival. Researchers have investigated our ability to prioritize the processing of animacy-related information (e.g., Barrett, 2005; New et al., 2007), and more recently, memory benefits for animate entities. For example, Nairne et al. (2013) presented words that referred to animate beings and inanimate objects and tested retention using a recognition test. Across three trials of word presentation, recognition was greater for animate words compared to inanimate words. Subsequent work replicated this effect using picture recognition (Bonin et al., 2014) and paired-associates (VanArsdall et al., 2013). In the latter example, participants were presented with non-words (e.g., FRAV, JOTE) that were paired with human characteristics (e.g., believes in God) or inanimate object properties (e.g., has sharp edges). They were asked to rate the likelihood that each nonword represented a living or nonliving thing. A recognition and free recall test were used to assess participants' memory for the nonwords. Consistent across two experiments, nonwords processed as humans were remembered better than the same nonwords processed as inanimate objects. Researchers examining animacy have argued that such findings support an evolutionary view that human memory was shaped by ancestral selection pressures to prioritize the processing of animacy.

The above-mentioned studies focused on adult participants. Research has also examined whether there is an early emerging cognitive bias toward preferential remembering of animacy. There is some

(indirect) evidence in support of this hypothesis. It appears that children can distinguish between animate and inanimate entities at a very young age (e.g., Mandler & McDonough, 1998; Rakison & Poulin-Dubois, 2001) and this is evident across cultures (e.g., Atran, 1998). In a similar vein, young children also appear to have good animate characteristic knowledge and evidence has suggested that children have a predisposition to rapidly learn about the dangerousness of animals (Barrett & Broesch, 2012). The claim for the existence of a bias toward the rapid detection of evolutionarily relevant threat stimuli has received support from visual search studies showing faster detection of fear-relevant than fear-irrelevant stimuli in both adults and very young children. LoBue and DeLoache (2008) examined response latencies when asked to find a single target picture among an array of eight distractors. Across three experiments, children, just like adults, were faster to detect a snake than three types of nonthreatening stimuli (e.g., flowers, frogs, and caterpillars). They argued that young children share the propensity of adults for particularly rapid visual detection of snakes. Such evidence provides support for theories positing the existence in humans of an evolved bias for the detection of evolutionarily relevant threat stimuli, although the precise stimulus attributes that underlie this bias is a topic for further research.

If we return to the developmental origins of the animacy effect, recent research that has examined this mnemonic advantage has primarily tested young adults. More recently, researchers have adapted the procedure for use with children (VanArsdall et al., 2013). Aslan and John (2016) extended these findings, examining non-word paired associate characteristics for human and (nonhuman) animals, as well as inanimate objects. Children 4-11 years of age were presented with nonword-property pairs (e.g., “BULA has four edges,” “LAFE builds nests”) and they were instructed to make a judgement as to whether it was likely a living or non-living thing. This was followed by a surprise old/new recognition test. They found superior recognition of nonwords paired with animate properties than (the same) nonwords paired with inanimate properties. This mnemonic animacy advantage held regardless of

whether the nonwords were “animated” by properties characteristic of humans or by properties characteristic of (nonhuman) animals. Aslan and John concluded that young children can distinguish between animate and inanimate entities, have sophisticated knowledge about those entities, and show rapid learning about characteristics of animals such as their dangerousness (LoBue & DeLoache, 2008). Such findings are similar to the survival processing effect and recent findings that this animacy effect emerges early in childhood suggest- that young children’s memory is tuned to process and retain fitness-relevant information. In addition to animacy advantages, other cognitive mechanisms, such as the processing of emotional information, have been examined for their mnemonic advantages.

Memory for Emotional Stimuli. Research suggests that we have a bias to remember emotional (especially negative) stimuli. From an evolutionary perspective it is especially relevant that we have a bias for negative stimuli, which alert us to signs of potential threat or harm (Calvo & Lang, 2004; Levine & Edelstein, 2009; Vaish et al., 2008). There is growing acknowledgment that priority plays an important role in the emotion–memory interaction (Mao et al., 2017) whereby it is assumed that emotional arousal enhances the memory of prioritized (e.g., goal relevant) stimuli (Lee et al., 2015; Sakaki et al., 2014). It appears that children also display such a negativity bias, attending to and processing negative over neutral and positive stimuli (Baltazar et al., 2012; Baumeister et al., 2001; Chae et al., 2011; LoBue, 2009). Such biases in attention have led to “enhanced” memory for negative stimuli.

Adults show a tendency to remember threatening over non-threatening faces, an advantage indicative of a system rooted in cognitive evolution. Children have also learned that it pays to be vigilant. Kinzler and Shutts (2008) examined a face recognition memory advantage in preschool-age children (aged 3-4 years). They were presented with faces that were said to have committed nice or mean actions (e.g., “Kevin is always nice. Today he brought in cookies and everyone got some” or, “Kevin is always mean. Today he stole everyone’s cookies and no one got any”). At test, children were presented

with each face and a distractor, and were asked to identify the face they had seen before (e.g., “which one was Kevin”). Children showed better face recognition for faces that were associated with mean actions compared to those that were associated with nice actions. They also demonstrated that this was not just a valence effect. When presenting the same faces but providing information that meant the person was happy or sad, the children showed equal memory ability for both types of trials. Kinzler and Shutts argued that this finding whereby children only showed enhanced face memory for threatening individuals, and not negative information that was non-threatening, suggests a useful strategy to reduce the chance of future personal harm. That this exists early in childhood suggests that attention to potential perpetrators does not emerge through experience, but rather, that we are predisposed to remember those who may cause harm. It may be that there is an evolved process to support memory for threatening individuals. Alternatively, such individuals may simply be more arousing, something that could be the proximal cause of the memory patterns evinced by children (as well as adults). An adaptive memory system that favors arousing stimuli due to its salient nature still fosters children’s attention to and enhanced memory for people who may cause us harm. Indeed, in more naturalistic settings, recall from children for negative events was more coherent and included more discussion of their thoughts and emotions than those for positive events, although their narratives of positive events included more descriptive details than for negative events (Fivush et al., 2003). Perhaps with worrying consequences, some studies have shown that both adults (see Bookbinder & Brainerd, 2016) and children (e.g., Howe et al., 2010) produce higher levels of false recollection for negative stimuli. The suggestion here is that negative information is less discriminable given how densely connected such valenced stimuli can be (e.g., Howe et al., 2010). It appears that what we will later remember depends on the attention we give it, how we encode and store it, and the context in which we retrieve it. Some information that we encounter will be more important to remember than others. It is beneficial to be attentive to stimuli that have the potential to cause harm (e.g., Kinzler & Shutts, 2008; LoBue & DeLoache, 2008), but

proximate mechanisms that lead to enhanced processing of salient and arousing stimuli may mediate the survival-information effect.

Episodic Future Thought

We consider the ability to navigate our future and plan for possible contingencies that impact survival, part of memory's adaptive function. Similar to how episodic memory allows us to re-experience a past event, researchers have proposed that episodic future thinking allows us to pre-experience our future (Atance & O'Neill, 2001) and plan for situations that will ensure our survival. Tasks used to measure episodic future thinking incorporate the notion of self and future. Atance and O'Neill developed the *trip task*. In the trip task, children are asked to talk about the event of going on a trip. Such an event should have many different outcomes and differ widely for different children. It should include more instances of the unknown. Depending on the trip, children will need to anticipate such situations as getting hungry, thirsty, cold, or tired. It should have less reliance on a script than a routine event such as "bedtime" where fewer outcomes are possible. Atance and O'Neill argued that children's ability to talk about novel situations and to incorporate uncertainty into their narrative about these situations may be markers which demonstrate the emergence of episodic future thinking. They asked a sample of 3-year-olds to pretend that they were going on a trip, presenting them with eight items from which they could choose three to bring. They found that around a third of children were able to reference future situations that could arise on the trip (e.g., "Because I'm gonna be hungry") and children's explanations most often contained future terms for thirst, hunger, and getting hurt. Based on these findings and others, episodic future thought is considered to emerge around four years of age and develop across the school years (Atance, 2008; Kerns, 2000; Smith et al., 2010). The ability to engage in episodic future thinking rests, in part, on cognitive component(s) which have yet to be definitively confirmed but likely involves theory of mind skills (i.e., the ability to envision the self in potentially

different situations) and an understanding of mental states and how they can be used to predict or explain one's own behavior (Astington et al., 1988). In addition, researchers have argued for the importance of parental talk. We know that parent talk can contribute to autobiographical memory development (e.g., Fivush, 1991) but discussing more novel future events with a parent can lead children to form more hypotheses about novel future events than about familiar future events. It is clear that there are benefits for future thought that support planning and problem solving. Many of the requirements that allow for this behavior are thought to be available to young children and rely on cognitive flexibility. That is, the emergence of flexible, event-independent ways of representing temporal locations, flexible thinking and the ability to hold a series of actions or events in mind while considering their efficiency and order, and the ability to shift perspective and project future self (see McCormack & Atance, 2011).

Accounting for the Fitness-relevant Processing Advantage

So far, we have reviewed a number of paradigms and a variety of stimuli which examine developmental trends in adaptive memory. Such findings appear to provide compelling evidence that the survival processing effect and memory benefits for survival relevant information is developmentally invariant. As all of these studies have suggested, from an evolutionary perspective, these findings support a well-documented theory that selection pressures from our ancestral past left "footprints" in our memory system. What remains in question is whether these footprints are a predisposition to favor the processing of fitness relevant information, through the emergence of a fitness-relevant memory system, or whether it has more to do with the greater likelihood of engaging various proximate mechanisms in these tasks.

Scott-Phillips et al. (2011) referred to the need for ultimate and proximate distinctions for evolutionary theory. Such distinctions allow us to provide a more complete explanation of the evolution of certain traits or behaviors. Put succinctly, ultimate explanations are concerned with the fitness

consequences of a trait of behavior, the “why” question for the existences of such a trait. Proximate mechanisms are concerned with the mechanisms that underpin the trait or behavior, referring to “how” the trait exists. Such explanations are not in opposition, and we do not favor one over the other, but rather, to completely understand a behavior we need to look at both. Scott-Phillips et al. gives the explanation of crying behavior in babies. The ultimate explanation is that it elicits care and defense from the caregiver which increases survival. Proximate explanations include external triggers, for example, hunger, cold, separation, and internal mechanisms involved in the initiation and cessation of crying.

Here, we consider an ultimate-proximate explanation for adaptive memory. Research has shown a survival-processing advantage (Nairne et al., 2008), but why is memory sensitive to survival relevant information? The ultimate explanation is that to increase chances of survival, our memory systems must allow us to give priority to fitness-relevant information. The proximate explanations of adaptive memory refer to the mechanisms that underlie our ability to prioritize such fitness-relevant information (Kazanas & Altarriba, 2015). Research has demonstrated that such mechanisms might include: elaboration (such that it evokes imagination or consideration of information related to the task), self-reference (encoding the information with particular relevance to self), and relational and item-specific processing (the ability to encode both the relationships that exist among concepts and objects as well as the ability to encode specific details about those concepts and objects). Thus, the proximate mechanisms refer to the memory processes that have emerged to accomplish this particular evolutionary survival-processing function of adaptive memory (Howe & Otgaar 2013). We will now examine the evidence that supports these types of processing, individually or combined, to explain the adaptive memory effects in both adults and children.

Self-referential processing. Research examining the comparative value of survival processing in relation to other deep-processing encoding conditions suggests an advantage of survival processing. Nairne et al. (2009) compared standard grasslands survival processing instruction to several encoding

tasks including pleasantness, imagery, and self-referent ratings. For the latter, participants were instructed:

“In this task, we would like you to think of personal experiences you have had in your life. We will present you with a series of words, and for each word we would like you to rate how easily the word brings to mind an important personal experience.” The rating scale ranged from 1 (very difficult) to 5 (extremely easy).

Nairne et al. found an unequivocal mnemonic benefit for survival processing with significantly enhanced retention relative to standard deep-processing controls, considered to represent the “best of the best” of known encoding procedures. They argued that this result revealed a processing system which has evolved to be tuned or biased to retain information that is processed for fitness.

This is a strange finding for many as few things are more self-relevant than one’s personal survival. However, others have argued that at least the self-referent task in this study would not produce a self-reference effect. The list words commonly used, all of which were nouns, include such items as “river,” “snake,” “liver,” “dirt,” and “fabric.” Given the nature of the self-referential task used by Nairne and colleagues, it is quite reasonable to assume that it entailed processing nouns with respect to episodic memory. However, as highlighted by Klein et al. (1989), not all self-reference tasks, particularly those using noun stimuli, are equivalent in their memorial potency. If participants are simply asked to rate how easily a word brings to mind an important personal experience, this often fails to elicit a mnemonic benefit. One key factor for the efficacy of the self-referent effect is the use of an autobiographical context for encoding. In fact, research has shown that when comparing a self-referential processing effect where participants were first asked to retrieve an episodic memory before rating how easily the words bring to mind a personal experience, there was no survival-processing benefit. Klein (2013) used several encoding conditions including the standard survival encoding task, the self-referential task use by Nairne et al. (2009), and a self-referential task used by Klein et al. (1989). The

instruction here asks the participants to bring to mind an important personal experience involving each of the items presented on the page and rate how easily the item brought to mind an important experience. This instruction, although trivial, asks the participant to retrieve an episodic memory, which is necessary for the sort of recall enhancement found with the episodic-based self-reference tasks using nouns as stimuli. Klein (2013) found that both the survival processing and Klein's self-referential encoding task produced better recall than the modified task used by Nairne and colleagues, while the former conditions did not differ. This suggests that, at least in part, self-referential memory retrieval is a component of the survival processing effect, playing a part in the high levels of recall found with survival processing.

Item-specific and relational processing. Survival processing tasks not only require participants to consider encoding of information that is item-specific, something that heightens discriminability and distinctiveness from other items, but also relational processing, something that allows items to be integrated and well organized for better retention. For example, tasks can involve encoding information in relation to specific attributes of an individual predator, but also information about all similar predators, their hunting characteristics, and their characteristic features. A combination of both processing types has a more powerful effect on retention than either does on their own (e.g., Einstein & Hunt, 1980; Hunt & Einstein, 1981; Hunt & McDaniel, 1993). Although survival tasks typically draw on both types of processing, control tasks often involve one or the other.

Nairne and Pandeirada (2008) aimed to test this relational/item-specific processing explanation by comparing the survival task to a control task thought to promote both processing types. Although a pleasantness ratings task is typically a method used to ensure item-specific processing (e.g., Burns, 1993; Burns & Schoff, 1998), Nairne and Pandeirada used this task with list items that were categorically related. Research supports a pleasantness rating task of related list words, demonstrating that this can promote the processing of both item-specific and relational information and enhance recall

performance that is superior to conditions promoting only item-specific or only relational processing (e.g., Burns, 1993; Einstein & Hunt, 1980). Although their results showed clustering by category during recall for both tasks, the survival processing group still produced enhanced recall compared to the pleasantness rating group, thereby suggesting that survival processing enhances recall above that produced by a group performing a task that used item-specific and relational processing.

However, Burns et al. (2011) argued that Nairne and Pandeirada's (2008) procedure may not have been optimal for equating relational processing in comparison to the survival task. They argued that the categorical lists were inherently related to survival which may have favored the survival processing condition. Burns et al. further examined the relational/item-specific explanation for survival processing. A recall advantage was obtained for survival processing compared with conditions that promoted only item-specific processing or only relational processing. However, when a pleasantness ratings task was compared to a survival task where the lists were categorical in nature but not specifically associated with survival, and both tasks relied on relational and item-specific processing, the survival processing effect was eliminated.

Elaboration and distinctiveness effects. Tasks that elicit more elaborative processing should lead to greater distinctiveness and relational processing. Control condition scenarios used in fitness relevant memory studies tend to be more ordinary (i.e., moving home, going on holiday, getting lost in a city). A typical participant will have experience with these scenarios. However, few will have experienced the need to survive in the grasslands of a foreign country. Researchers argue that participants will need to resort to considerable elaboration and imaginative processing to accomplish the rating tasks associated with these scenarios. Indeed, Kroneisen and Erdfelder (2011) argued that the survival-processing effect can be traced back to the richness of encoding triggered by the survival-relevance-rating task. They argued that relevance ratings in a complex survival scenario provide a particularly inspiring and rich encoding context. Participants have to think about the many distinct characteristics of an object to

consider its relevance to a survival problem. When evaluating the relevance of words in a complex grasslands survival context, participants may easily think of a number of different perceptual and functional object features or other possible associations to a word. They argued that the degree to which survival processing invites rich encoding predicts the enhanced recall we see with survival processing. Such a hypothesis has been tested by comparing the standard survival task to ones where participants only focus on a single problem or technique. Specifically, Kroneisen and Erdfelder used a short survival scenario:

“In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land. *After searching along the surrounding area and the debris flushed to the shore along with you, you are bound to realize that you have a major problem of survival: you have no potable water.* We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this survival situation.”

In comparison to the standard grasslands scenario, this focus on a single major problem, lack of water, produced significantly poorer recall. With this more focused task, a survival advantage in comparison to the moving scenario could not be found. Thus, when the scenario is matched for its elaborative nature and richness of detail, the survival processing advantage is eliminated. In fact, memory performance can be enhanced in comparison to the survival scenario if the task is novel and elaborative. Although adaptative memory researchers (e.g., Nairne & Pandeirada, 2010) have argued that the survival advantage is a result of how our memory systems have evolved to help us remember fitness-relevant information which has ancestral priorities, Soderstrom and McCabe (2011) demonstrated a recall advantage for non-ancestral but elaborate scenarios (grasslands and zombies, city and zombies outperformed grasslands and predators). They concluded that ancestral environments have no specific advantage with respect to encouraging survival-relevant memory benefits and that zombies are likely to evoke more specific imagery and more elaborate encoding. These studies show, at least in part, that the

survival processing advantages in memory can be linked to elaborate and rich encoding, regardless of the ancestral relevance of the scenario presented (also see Howe & Derbish, 2014).

Conclusions

According to Nairne and colleagues (e.g., Nairne & Pandeirada, 2010; Nairne et al., 2012), the survival processing advantage is evidence of human learning and memory that has been tuned through a selective evolutionary process to retain fitness relevant information for survival. However, these studies above have shown us the degree to which survival processing invites elaborative, distinctive, relational and self-referential encoding that can predict the memorial advantage of survival processing and other adaptive memory advantages (Howe & Derbish, 2014; Kroneisen & Erdfelder, 2011). In addition, as stated by Howe and colleagues (Howe 2006, 2011; Howe & Otgaar 2013), that these effects are developmentally invariant does not mean that fitness relevant survival processing is an adaptive priority, but rather, that the proximate mechanisms that underly that advantage appear early in life supporting the findings that show that a fitness-relevant advantage can be observed in children's memory.

Throughout this chapter we have considered broad survival and adaptive memory processing advantages, presenting an explanation that does not rely upon the ancestral adaptive significance of such processing, but rather the use of memory processes that enhance retention. Processing of fitness-relevant information utilizes several processes at once which often produces superior mnemonic advantages. These processes develop early in childhood and can be observed in a variety of contexts. We do not dispute that our memory system today is the outcome of evolutionary pressures that have resulted in myriad proximate mechanisms that we have reviewed here. However, that a survival-processing advantage is a special component of an adaptive memory system, one that is developmentally invariant, is not necessary for an evolutionary hypothesis of memory. As Howe and Otgaar (2013) concluded, there is a real need for future scientific enquiry to help understand the

functional properties of memory, examining both the role of proximate mechanisms in adaptive memory more generally and survival-processing specifically. Research has begun this trajectory of study but understanding how mechanisms develop and how this is relevant to changes in our adaptive memory systems is still to be discovered.

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