



City Research Online

City St George's, University of London

Citation: Howe, M. L. (2013). Securing the future by remembering the past: But just when does this past and future begin to develop?. *Journal of Applied Research in Memory and Cognition*, 2(4), pp. 237-239. doi: 10.1016/j.jarmac.2013.09.002

This is the accepted version of the paper.

This version of the publication may differ from the final published version. To cite this item please consult the publisher's version.

Permanent repository link: <https://city-ref-test.eprints-hosting.org/id/eprint/4195/>

Link to published version: <https://doi.org/10.1016/j.jarmac.2013.09.002>

Copyright and Reuse: Copyright and Moral Rights remain with the author(s) and/or copyright holders. Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge, unless otherwise indicated, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way. For full details of reuse please refer to [City Research Online policy](#).

RUNNING HEAD: DEVELOPMENT OF MEMORY FUTURES

Securing the Future by Remembering the Past: But just when does this Past and
Future Begin to Develop?

Mark L. Howe

City University London, UK

Address correspondence to: Mark L. Howe

Department of Psychology

City University London

Northampton Square

London, EC1V 0HB U.K.

e-mail: Mark.Howe.1@city.ac.uk

phone: +44 020 7040 3346

Word Count = 2080 (text only).

Keywords: Memory development, episodic foresight, future thinking, adaptive
memory, prospective memory.

IN PRESS: *Journal of Applied Research in Memory and Cognition*

Securing the Future by Remembering the Past: But just when does this Past and Future Begin to Develop?

Klein (2013) suggests that at least one evolutionary pressure that led to the emergence of associative memory is the need for organisms to anticipate and plan for the future. That is, we remember the past in the service of securing our future survival, something that has considerable fitness relevance. In fact, those who can use the past to more effectively anticipate the future must surely enjoy increased opportunities for reproductive success.

The current zeitgeist in memory research is sympathetic with Klein's (2013) view, particularly among those who dabble in what is known as "adaptive memory" (see articles in Howe & Otgaar, in press and chapters in Schwartz, Howe, Toglia, & Otgaar, 2014). Although most agree that memory for the past is a harbinger for understanding the present and anticipating the future in adult humans, there is less consensus concerning whether memory behaves in a similar fashion in nonhuman animals as well as younger humans (i.e., infants and toddlers). Klein (2013, pp. xxx-xxx) argues that, "all organisms capable of memory are, of necessity, oriented toward the future ... Species-specific differences in future-orientation trade on complexity and temporal scope of anticipatory and planning abilities, not on their presence or absence."

Although organisms endowed with associative memory may be able to use the past to anticipate the future, the question posed in this article is one about when this episodic foresight or future thinking¹ emerges in an organism's ontogeny. Specifically, when has an organism stored enough of its past to anticipate its future? That is, if future orientation is not present at birth, requiring some accumulation of

experience, then at what point has sufficient experience been stored in memory to anticipate the future. Moreover, it is not simply a matter of the quantity of what has been stored, but more obviously, the domain of that experience. That is, surely one cannot anticipate where to find food if one's stored experiences have not involved previous food-related experiences including attempts to locate food in the past.² Thus, like other adaptive behaviors, the episodic foresight component of memory functioning may require certain developmental experiences to occur before it begins to function (i.e., the expression of an adaptation may be *experience expectant* or *experience dependent*; e.g., see Howe, 2011). Specifically, the expression of a fitness-relevant memory system may not occur until there have been sufficient encounters with and knowledge of the situations relevant to current and future need states.³

Although to qualify as an adaptation a behavior must emerge at some point during an organism's life, this does not mean that adaptations need to be present early in life. Indeed, many adaptive behaviors emerge long after birth (e.g., bipedal locomotion at around 12 months, language usually at 18-24 months, secondary sex characteristics during puberty; see Buss, Haselton, Shackelford, Bleske, & Wakefield, 1998; Confer et al., 2010). In terms of episodic foresight, it is reasonable to assume that this adaptive component of memory might emerge even later in some of today's (Western) cultures, given the rather extended periods of infancy and childhood that many humans experience (see Gopnik, 2009).

To answer this ontological question, I will restrict my comments to the human developmental literature. Although some of the paradigms used to examine this question in humans (i.e., those involving nonverbal responses) have also been used to examine this same question in nonhuman animals (e.g., Martin-Ordas, Atance, & Call, in press; Schwartz, Colon, Sanchez, Rodriguez, & Evans, 2002), I will simply

consider the developmental trajectory of episodic foresight in young children. However, before considering the episodic foresight literature proper, it is important to note that even very young infants are capable of anticipating future events. For example, 3- (e.g., Adler & Haith, 2003; Adler, Haith, Arehart, & Lanthier, 2008) and 4-month-olds (e.g., von Hofsten, Kochukhova, & Rosander, 2007) can visually track an object that becomes occluded and anticipate where it should reappear. This anticipatory behavior is not just based on pre-occlusion visual tracking skills or other low-level visual processing mechanisms, but involves something more cognitive; that is, the infant tracks the objects in their ‘mind’s eye’ even when those objects disappear behind the occluder (von Hofsten et al., 2007). Indeed, infants not only exhibit surprise if the occluded object does not reappear in the anticipated position, but they are similarly surprised if there are changes in the object’s appearance (e.g., height, color) or its identity when it finally does reappear. This research shows that temporal information plays an important role very early in life and that even very young infants anticipate future outcomes based (perhaps) on memory for how objects have behaved in the past. Together, these studies on an infant’s grasp of object permanence (its continued existence behind the occluder), its physical properties (height, color, identity), and trajectory (where it should reappear) not only provide valuable information about early expectant (visual) behaviors, but also about what might be the precursors to later future thinking.

Although perhaps a precursor to the future planning aspects of associative memory, these results do not demonstrate the sort of episodic foresight that Klein (2013) is referring to.⁴ To date, such studies have only been conducted with preschool-age children (3- to 5-year-olds). Here, there are at least two ways in which young children’s future planning has been examined—prospective memory and

episodic foresight. In prospective memory studies, children are asked to remember to do something in the future (e.g., bring an item for show-and-tell, check the oven in 20 minutes, return a book to a friend next time you see them; see Aberle & Kliegel, 2010; Atance & Jackson, 2009). Although some of these studies have reported age differences favoring older children, other studies have failed to find age differences even among the youngest preschool children (for a review, see Kvavilashvili, Kyle, & Messer, 2008). Of course, prospective memory tasks may not involve planning *per se* as they may simply tap children's ability to remember the instruction to do something later.

More direct tests of children's episodic foresight have been conducted using both nonverbal (e.g., Metcalf & Atance, 2011) and verbal (e.g., Atance & Sommerville, in press; Hayne, Gross, McNamee, Fitzgibbon, & Tustin, 2011; Richmond & Pan, 2013; Scarf, Gross, Colombi, & Hayne, 2013) tests. Like the research on prospective memory, developmental differences in episodic foresight can appear and disappear depending on the procedure implemented to examine children's future planning abilities. For example, in a typical verbal version of this paradigm, children might be asked to talk about an event that happened in the past (e.g., earlier that day, yesterday, or events more distant in the past) and then about an event that might happen in the future (e.g., later the same day, tomorrow, or even further into the future). Here, 3-year-olds often provide less information in their narratives than 4- and 5-year-olds for both retrospective and prospective memories, suggesting a developmental shift in episodic memory (remembering the past) and episodic foresight (anticipating the future) between the ages of 3 and 4 years (see Busby & Suddendorf, 2005).

However, developmental changes have not always been found. For example, when the task is made easier for younger children (e.g., by providing a visual timeline so they can physically track both the past and the future), differences in the performance of 3- to 5-year-olds virtually disappear (Hayne et al., 2011). Similarly, in a nonverbal task (remembering to save marbles for a future task), there were no differences in the amount saved among 3- to 5-year-olds (Metcalf & Atance, 2011).⁵

Still other studies have shown important developmental changes in children's episodic foresight. Atance and Sommerville (in press) examined episodic foresight in 3-, 4-, and 5-year-olds. Here, children were given a problem in one room and, following a delay, were taken to a second room where they could select an item to solve the earlier presented problem. Children were also asked questions about the original problem to see whether they correctly remembered what it was in order to determine the relationship between retrospective episodic memory and prospective problem solving. The results showed that children's ability to select the correct item to secure the solution to the problem increased with age, but this relation was mediated by memory for the original problem. That is, using regression analyses, memory for the past, not age, predicted correct item selection. Thus, the ability to remember the past (i.e., the problem in this case) is a major predictor of episodic foresight. That both episodic memory and episodic foresight develop in tandem is consistent with neuroscientific evidence demonstrating that both of these processes rely on the activation of many of the same neural regions (e.g., Addis, Pan, Vu, Laiser, & Schacter, 2009).

Scarf et al. (2013) also examined episodic memory for the problem and used a delay between problem presentation and item selection. They showed that despite being able to form episodic memories for the problem, when the delay between the

problem and solution selection was longer than 15 minutes, 3-year-olds did not retain the relevant problem information over the delay. In contrast, 4-year-olds could retain this information as long as one week. These results add to the growing consensus that memory for the original problem is key to episodic foresight and that as children develop they are better able to retain that information over longer and longer intervals. Indeed, these findings are in line with a wealth of evidence showing that improvement in children's ability to store information in memory (i.e., consolidation) is critical to the development of episodic memory (Bauer, 2009). What Scarf et al. (2013) have added is that these changes in retention of past experiences are also critical to the development of episodic foresight.

Finally, Richmond and Pan (2013) have demonstrated that like the changes that occur in children's ability to consolidate information in storage, advances in children's ability to bind elements of the past into a more integrated, relational associative network is also predictive of their performance on episodic foresight tasks. Although surely binding together past experiences into more integrated traces is also related to changes in children's executive function (e.g., inhibition, working memory; see Suddendorf & Corballis, 2007), memory for the past is necessary for anticipating future outcomes. That is, remembering previous relevant experiences (in these cases, the earlier presented problem) is necessary for successful episodic foresight.

So, although associative memory may have evolved to afford organisms that possess it with the fitness-relevant consequence of being able to anticipate the future through remembering the past, such benefits may not be available to humans (or nonhuman animals) immediately upon birth. This is a critical insight that needs to be factored into any theory about the evolution of memory, regardless of which direction we believe is best to study the fitness-relevant role of an adaptive memory system.

Indeed, what the research reviewed here suggests is that there exists a specific developmental trajectory for this adaptive advantage, one that unfolds as a consequence of the development of episodic memory more generally. Although there exist early precursors to episodic foresight (e.g., visual anticipation), ones that involve an immature form of episodic memory (e.g., one that has recently coded the properties of objects and their trajectory through space), research has shown that for humans, at least, true future planning of the sort Klein (2013) envisages may not emerge until three years of age (but see Footnote 5). As this aspect of memory emerges, there are at least four proximate mechanisms that have been identified that need to be in place for the mature functioning of episodic foresight: (1) development of storage and retention processes (i.e., consolidation; e.g. Scarf et al., 2013), ones that depend on neurological maturation (e.g., Bauer, 2009); (2) development of retrieval skills so the past that is available in storage is also accessible (e.g., Atance & Sommerville, in press); (3) age-related changes in binding so that past experiences become better integrated in associative networks (e.g., Richmond & Pan, 2013), again something that depends on neurological maturation (e.g., Townsend, Richmond, Vogel-Farley, & Thomas, 2010); and (4) age-related improvements in executive processing (e.g., response inhibition, working memory; see Suddendorf & Corballis, 2007). Together these behavioral and neurobiological developments determine the emergence of both episodic memory for the past and episodic foresight used to plan for the future. Indeed, it is because humans are animals that rely on the accumulated knowledge of our past experiences in order to imagine and plan for our future, childhood tends to be a much more protracted period than that of other animal species (also see Gopnik, 2009).

References

- Aberle, I., & Kliegel, M. (2010). Time-based prospective memory performance in young children. *European Journal of Developmental Psychology, 7*, 419-431.
- Addis, D. R., Pan, L., Vu, M., Laiser, N., & Schacter, D. L. (2009). Constructive episodic simulation of the future and the past: Distinct subsystems of a core brain network mediate imagining and remembering. *Neuropsychologia, 47*, 2222-2238.
- Adler, S. A., & Haith, M. M. (2003). The nature of infants' visual expectations for event content. *Infancy, 4*, 389-421.
- Adler, S. A., Haith, M. M., Arehart, D. M., & Lanthier, E. C. (2008). Infants' visual expectations and the processing of time. *Journal of Cognition and Development, 9*, 1-25.
- Atance, C. M., & Jackson, L. K. (2009). The development and coherence of future-oriented behaviors during the preschool years. *Journal of Experimental Child Psychology, 102*, 379-391.
- Atance, C. M., & Sommerville, J. A. (in press). Assessing the role of memory in preschoolers' performance on episodic foresight tasks. *Memory*.
- Bauer, P. J. (2009). *Remembering the times of our lives: Memory in infancy and beyond*. Mahwah, NJ: Erlbaum.
- Busby, J., & Suddendorf, T. (2005). Recalling yesterday and predicting tomorrow. *Cognitive Development, 20*, 362-372.
- Buss, D. M., Haselton, M. G., Shackelford, T. K., Bleske, A. L., & Wakefield, J. C. (1998). Adaptations, exaptations, and spandrels. *American Psychologist, 53*, 533-548.

- Ceci, S. J., Fitneva, S. A., & Williams, W. M. (2010). Representational constraints on the development of memory and metamemory: A developmental-representational theory. *Psychological Review*, 117, 464-495.
- Confer, J. C., Easton, J. A., Fleischman, D. S., Goetz, C. D., Lewis, D. M. G., Perilloux, C., & Buss, D. M. (2010). Evolutionary psychology: Controversies, questions, prospects, and limitations. *American Psychologist*, 65, 110-126.
- Gopnik, A. (2009). *The philosophical baby: What children's minds tell us about truth, love, and the meaning of life*. London: The Bodley Head.
- Hayne, H., Gross, J., McNamee, S., Fitzgibbon, O., & Tustin, K. (2011). Episodic memory and episodic foresight in 3- and 4-year-old children. *Cognitive Development*, 26, 343-355.
- Howe, M. L. (2011). *The nature of early memory: An adaptive theory of the genesis and development of memory*. New York: Oxford University Press.
- Howe, M. L., & Otgaar, H. (2013). Proximate mechanisms and the development of adaptive memory. *Current Directions in Psychological Science*, 22, 16-22.
- Howe, M. L., & Otgaar, H. (Eds.) (in press). Adaptive memory: The emergence and nature of proximate mechanisms. [Special Double Issue] *Memory*, 22 (1-2).
- Klein, S. B. (2013). The temporal orientation of memory: It's time for a change of direction. *Journal of Applied Research in Memory and Cognition*, 2, xxx-xxx.
- Kvavilashvili, L., Kyle, F. E., & Messer, D. J. (2008). The development of prospective memory in children: Methodological issues, empirical findings, and future directions. In M. Kliegel, M. McDaniel, & G. O. Einstein (Eds.), *Prospective memory: Cognitive, neuroscience, developmental, and applied perspectives* (pp. 115-140). Mahwah, NJ: Erlbaum.

- Martin-Ordas, G., Atance, C. M., & Call, J. (in press). Remembering in tool-use tasks in children and apes: The role of the information at encoding. *Memory*.
- Metcalf, J. L., & Atance, C. M. (2011). Do pre-schoolers save to benefit their future selves? *Cognitive Development*, 26, 371-382.
- Richmond, J. L., & Pan, R. (2013). Thinking about the future early in life: The role of relational memory. *Journal of Experimental Child Psychology*, 114, 510-521.
- Scarf, D., Gross, J., Colombo, M., & Hayne, H. (2013). To have and to hold: Episodic memory in 3- and 4-year-old children. *Developmental Psychobiology*, 55, 125-132.
- Schwartz, B. L., Colon, M., Sanchez, I., Rodriguez, I., & Evans, S. (2002). Single-trial learning of “what” and “who” information in a gorilla (*Gorilla, gorilla, gorilla*): Implications for episodic memory. *Animal Cognition*, 5, 85-90.
- Schwartz, B. L., Howe, M. L., Toglia, M. P., & Otgaar, H. (Eds.) (2014). *What is Adaptive about Adaptive Memory?* New York: Oxford University Press.
- Suddendorf, T., & Corballis, M. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans? *Behavioral and Brain Sciences*, 30, 299-351.
- Townsend, E., Richmond, J., Vogel-Farley, V., & Thomas, K. (2010). Medial temporal lobe memory in childhood: Developmental transitions. *Developmental Science*, 13, 738-751.
- Tulving, E. (2005). Episodic memory and autonoesis: Uniquely human? In H. S. Terrace & J. Metcalfe (Eds.), *The missing link in cognition: Origins of self-reflective consciousness* (pp. 3-56). New York: Oxford University Press.

Von Hofsten, C., Kochukhova, O., & Rosander, K. (2007). Predictive tracking over occlusions by 4-month-old infants. *Developmental Science*, 10, 625-640.

Footnotes

¹For the purposes of this article, these two terms will be used interchangeably.

²This question has to do with the development of an organism's knowledge base, something that has been studied extensively in human development (e.g., Ceci, Fitneva, & Williams, 2010). Because of length constraints, and because of the seeming obviousness of the proposition that domain relevant experience may be necessary for anticipating similar events in the future, there will be no additional discussion of this topic in this article (but see discussion in Howe, 2011; Howe & Otgaar, 2013).

³ Of course, because these critical developmental experiences can differ between individuals within and across cultures, fitness-relevant aspects of memory may not emerge at the same time in all children. Although, as Klein (2013) opines, we may all eventually exhibit episodic foresight, the developmental course of the emergence of this adaptive memory effect may vary considerably (also see Howe & Otgaar, 2013).

⁴Both Klein (2013) and Tulving (2005) suggest that episodic memory (remembering the past) and episodic foresight (anticipating the future) are accompanied by auto-noetic awareness (a feeling that one is reliving the past or mentally travelling into the future, respectively). Of course, such a requirement rules out nonverbal organisms (nonhuman animals and preverbal humans) because there is no way for them to report their conscious experiences when remembering the past or planning for the future. Although I will not pursue this issue in depth here, it is important to point out that (1) auto-noetic awareness may be a simple epiphenomenal component that arises in adult humans when remembering the past or anticipating the future, not a necessary one, and (2) children not only fulfill all of the other requirements associated with possessing episodic memory and foresight, but, whether epiphenomenal or not,

even 3-year-olds provide first person accounts of past experiences and future planning (e.g., Hayne, Gross, McNamee, Fitzgibbon, & Tustin, 2011), consistent with the autonoetic requirement.

⁵ Despite the availability of nonverbal procedures, researchers have not tested episodic foresight in children younger than three years of age. Because of this, we do not know whether children younger than three years of age evince future planning. Future research is well advised to adapt these procedures for use in younger children, much in the same way nonverbal procedures have been used to examine future-oriented behavior in nonhuman animals (Martin-Ordas et al., in press; Schwartz et al., 2002).