

Supplementary appendix

Insofar as there may be novel ideas in this paper, we thought it might be of interest to the reader to understand how those novel ideas developed.

AEB has been interested in consciousness and the biological basis of thought since high school when he avidly read the work of Jung, Freud, Adler, Erikson, and other psychologists. At Haverford College, he continued this interest, double majoring in philosophy and chemistry to get at “both ends” of the problem. There AEB met fellow philosophy major KAR, who, after spending time as a student at Oxford, obtained a PhD in philosophy at Rutgers. While in medical school AEB continued his interest, choosing neurology as the specialty he thought best suited to pursue questions such as the biological basis of cognition.

While in residency, in 1996, AEB attended the Tucson conference, “Toward a science of consciousness,” where he met speaker and professor Daniel Schacter. Schacter had written the section on consciousness in Gazzaniga’s now-classic textbook, *The Cognitive Neurosciences*. AEB pursued postdoctoral studies in the experimental psychology and cognitive neuroscience of memory (including false memory) with Schacter from 1997-2000. False memory studies were particularly appealing to AEB as it often produced confident, conscious recollections of events that never occurred. At that time, AEB met EAK, then a Harvard undergraduate working in Schacter’s lab, who taught AEB how to perform his first experimental psychology experiment.

Over the next several years, AEB learned to care for individuals with Alzheimer’s disease and other dementias, as well as to adapt the experimental psychology and cognitive neuroscience paradigms he learned in the Schacter lab to this population. Some studies had direct implications for consciousness, such as a collaboration with Brandon Ally and Jon Simons

that suggested the parietal old-new effect could be a reflection of the conscious, “Aha, I remember!” moment often experienced during successful recollection (Ally et al., 2008).

In 2002 AEB’s son was diagnosed with classic Kanner autism. AEB watched as, over the years, his son learned primarily through applied behavioral analysis, showing little or no ability to form any semantic memories or even long-lasting episodic ones. Beginning in about 2011, AEB began practicing mindfulness about a dozen minutes each day, experiencing just how difficult it is to be aware of one’s thoughts and to direct his conscious awareness to his breath or other object of his choosing.

With this background, the insights expounded upon in the present paper stemmed from AEB writing a book on memory with EAK, while at the same time reading William James’s *Principles of Psychology* (James, 1890) for the first time. *Principles of Psychology* is, of course, not only a tour-de-force of the biological basis of psychological principles as they were understood at the time, but also an enquiry into the nature of consciousness. As part of their work together on their memory book, EAK recommended that AEB read the book by Elisabeth Murray, Steven Wise, Mary Baldwin, and Kim Graham, *Evolutionary Road to Human Memory* (Murray et al., 2020). In the midst of these activities, AEB contacted to KAR, now professor of philosophy and healthcare ethics at MCPHS University in Boston, to collaborate together on a project studying consciousness. KAR suggested starting with the Susan Blackmore book, *Consciousness: A Very Short Introduction* (Blackmore, 2017). AEB had the interesting experience of reading about the order problems of consciousness (such as the clock chimes paradox) simultaneously in James’s 1890 and Blackmore’s 2017 books. Blackmore’s book went on to describe other order and timing problems in consciousness while James’s *Principles* went on to

describe different consciousness problems such as those that occur with hypnosis and what we would now call dissociative disorders including dissociative amnesia and dissociative identity disorder.

During the month of February, 2021, AEB realized that all of the timing and order issues of consciousness could be solved if consciousness was actually part of the episodic memory system. These ideas were discussed with KAR on 2/26/2021. Further thought and discussion expanded the idea, hypothesizing that consciousness was part of all of the explicit memory systems (working, episodic, and semantic). EAK had already explained to AEB that all of these explicit memory systems may be thought of as a single system—an idea also found in Murray et al. (2020).

Other relevant papers and books were then read systematically to determine (1) whether this idea had been proposed before (not that we are aware of) and (2) whether other theories (such as Dennett's, recurrent processing theory, higher order theories) and experiments (such as Casali et al., 2013 and Levinson et al., 2021) of consciousness were consistent with our hypotheses. At this point it seemed like a manuscript to explain this theory was appropriate. AEB provided the initial draft of the paper, with frequent, thoughtful suggestions, corrections, and additions by KAR. EAK provided both a critical review of the theory and helped expand and clarify many of the memory sections. Lastly, the reviewers of earlier versions of this manuscript made many invaluable suggestions and we believe that the current paper has been greatly improved as a result.