**Recollection and neurophysiological correlates of fictional memories**

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This project aims to understand the differences between experienced and fictional memories, from brain processes to behavioral effects. Episodic memories are characterized by a sense of re-living and visual imagery, and form the basis for developing an autobiographical self. Rubin et al. assessed the qualities of autobiographical memories by measuring variables including degree of reliving, visual and auditory imagery, emotions, setting, and belief[1]. Recent investigations have begun to probe the shared processes of remembering ("I went to the science museum 2 years ago") versus imagining ("I imagine myself graduating from college in the future"). Absent from the literature is thorough behavioral data on *fictional memories*: the memory of an imagined experience without an explicit reference to self, derived from fiction ("I can visualize Atticus Finch standing in a Southern courtroom"). Fictional memories are encoded and retrieved with subjective characteristics similar to veridical memories, and can be source of integrated knowledge about the world[2]; as such, they occupy an interesting and largely unexplored niche in memory research.

Conway et al. used electroencephalography (EEG) to record the dynamic process of retrieving true memories from the past[3]. Using the excellent temporal resolution of EEG, he established a distinct neural signature for what retrieving and maintaining autobiographical memory broadly looks like in the brain. First, there is activation in the prefrontal cortex, followed by additional temporo-occipital activation once the memory is formed. In a different task, subjects constructed future, imagined scenarios that were plausible and involved the self. Conway found that the real and imagined conditions relied heavily on the same brain regions. However, one difference that left prefrontal activation was *highest* during active maintenance of plausible imagined memories, presumably because this construction task is more effortful. Secondly, he found that temporal and occipital lobe activation is greater in the recall of real autobiographical memories, suggesting that imagined memories elicit stored sensory data, they do so less than real autobiographical memories.

In order to gain a theoretical and practical understanding of fictional memories, both behavioral and neurophysiological data are important; my proposed study will investigate these perspectives. I expect that many fictional memories can be vividly re-lived, they may not be associated with a particular time or place. I also expect fictional memories to evidence the dynamic localization of autobiographical memory. And if memories that are explicitly understood to be not real are incorporated into autobiographical memory, then they can influence identity and behavior. Developing a clearer picture of the neurophysiology of fiction and memory could illuminate how fiction-reading contributes to cognitive and affective development, or how fictional sources could be used intentionally by educators. If fictional memories do not show activity aligned to real and imagined autobiographical memories, then we must begin to explain how any episodic-like memory can exist without these networks.

I propose a research project to be carried out in two phases. Since there is not existing research on how to cue a fictional memory and it is critical to have reliable and controlled protocols for in the next, EEG-centered phase, I will first establish this protocol, as well as gather behavioral data through surveys. This first phase will also allow me to find and address any unanticipated sources of error in this novel process, and yield data to modify the design of the next phase. I will limit the study to fictional memories generated through the written word (e.g. novels and short stories). Subjects will be given a cue to recall a scene from a written work of fiction that can be strongly recalled; I will seek to gather 30 observations per subject. To gather

pilot data, EEG will be used to record cortical scalp potentials (more detailed methods are below). I anticipate that these memories—like veridical episodic memories— will differ in many ways within and between participants, including time since the last experience, personal interest, and amount of rehearsal. These qualities will be assessed via a questionnaire modified from Rubin et al.[1], which asks participants to rate their experience on a scale of 1 to 7 for questions that address recollection (like reliving), component processes (like visual imagery, spatial layout and emotions), and reported properties (like importance, rehearsal, and age of memory). The questions will be delivered after each cue through a provided keyboard.

In the second phase, I will use an EEG paradigm to examine the temporal dynamics of fictional memory construction. In two conditions, I will record scalp potentials with EEG while subjects recall and maintain (1) true memories of the past and (2) plausible imagined scenarios of the self; these are the scenarios studied by Conway, and will be used as controls. In the third (3) experimental condition, I will elicit the retrieval and maintenance of fictional memories using the protocol established in phase 1. I will seek to gather 5 observations for each condition per participant to balance the need for statistical rigor with maintaining a reasonable length for the study. Each trial will begin with the memory instruction "Real Memory," "Imagined Memory" or "Fictional Memory" on screen for 3s. A fixation stimulus will be presented for 3s, followed by the cue for one of the three scenarios. The cue will remain on screen until subjects indicate with a bimanual joystick pull that a memory has been successfully retrieved or generated. Participants will communicate that they were unable to retrieve a memory via a keyboard instruction, which will lead to a new trial. After the memory is retrieved, subjects will fixate on the screen and be instructed to hold in mind the memory for 7.5s. Then, the participant will then type a brief description of their memory using the keyboard provided.

In designing the cues and trials, it will be critical to balance cues and trials across participants. Subjects with high shifts in voltage throughout the trials will not be analyzed. Statistical significance will be assessed using a 3-way ANOVA involving the electrode levels and the 3 conditions of memory instruction. If fictional memories are experienced as episodic memories, I would expect to find patterns of cortical potential for fictional memories that are similar to that of the imagined future events. That is, the activation of posterior brain regions should be reduced compared to remembrances of real events. Of interest is the degree to which the prefrontal cortex is activated in the absent of a scenario that does not explicitly involve the self. Behaviorally, I expect to find that re-living of fictional memories to be comparable to veridical ones and primarily visual in nature. Of interest are differences in how the event comes to the subject "a coherent story," the perspective of the experience, and whether the memory comes back "in words" for a fictional memory that was, after all, delivered through language.

To support this work, I am seeking graduate programs which would allow me to combine behavioral and brain measures. I have established contact with several institutions where this would be possible and where training and facilities for EEG is available. For example, Elizabeth Marsh at Duke University studies fiction, false memories, and applications to educational practice. Conditional on my acceptance to the program, she has offered guidance for collaboration between her lab and others in the psychology and cognitive neuroscience departments. I am confident that with these supports, my experience designing novel experiments, and solid conceptual background, I can carry out this research within three years.

[1]Rubin, D.C., Schrauf, R.W., Greenberg, D.L. (2003). Belief and recollection of autobiographical memories. *Memory & Cognition*, 887-901. [2]Marsh, E.J., Meade, M.L., Roediger, H.L. (2009) Learning facts from fiction. *Journal of Memory and Language*, 519 –536. [3]Conway, M. A., Pleydell-Peace, C. W., Whitecross, S. E., & Sharpe, H. (2002). Neurophysiological correlates of memory for experienced and imagined events. *Neuropsychologia*, 1-8.