Brief Communications

Individual Differences in True and False Memory Retrieval Are Related to White Matter Brain Microstructure

Lluís Fuentemilla,1* Estela Câmara,1,2* Thomas F. Münte,2,1 Ulrike M. Krämer,2 Toni Cunillera,1 Josep Marco-Pallarés,2 Claus Tempelmann,2 and Antoni Rodriguez-Fornells1,5

1Departament de Ciències Fisiològiques II, University of Barcelona, Institut d’Investigació Biomèdica de Bellvitge, 08907 L’Hospitalet de Llobregat (Barcelona), Spain, 2Department of Neuropsychology, 3Center for Behavioral Brain Sciences, and 4Department of Neurology, Otto von Guericke University, 39120 Magdeburg, Germany, and 5Institució Catalana de Recerca i Estudis Avançats, 08010 Barcelona, Spain

We sometimes vividly remember things that did not happen, a phenomenon with general relevance, not only in the courtroom. It is unclear to what extent individual differences in false memories are driven by anatomical differences in memory-relevant brain regions. Here we show in humans that microstructural properties of different white matter tracts as quantified using diffusion tensor imaging are strongly correlated with true and false memory retrieval. To investigate these hypotheses, we tested a large group of participants in a version of the Deese–Roediger–McDermott paradigm (recall and recognition) and subsequently obtained diffusion tensor images. A voxel-based whole-brain level linear regression analysis was performed to relate fractional anisotropy to indices of true and false memory recall and recognition. True memory was correlated to diffusion anisotropy in the inferior longitudinal fascicle, the major connective pathway of the medial temporal lobe, whereas a greater proneness to retrieve false items was related to the superior longitudinal fascicle connecting frontoparietal regions. Our results show that individual differences in white matter microstructure underlie true and false memory performance.

Introduction

Individual differences in the way people retrieve past events from memory are well documented (Blair et al., 2002; Watson et al., 2005). Because of the constructive nature of human memory, the recollective process may sometimes elicit misattributions that a novel event or experience has occurred previously, thus creating a false memory (FM) (Schacter et al., 1996). False memories (FM) can be easily elicited in the laboratory (Roediger and McDermott, 1995). For example, in the Deese–Roediger–McDermott (DRM) paradigm, lists of semantically related words are presented during encoding (e.g., seat–sofa–stool–table, etc.) with one prototypical exemplar of the category (“lure” word: chair) missing. Interestingly, the lure word is often produced in free recall or recognition tests. True memory (TM) recognition has been hypothesized to rely on accurate, context-rich and vivid retrieval of an event (i.e., recollection), whereas FM recognition appears to reflect the feeling of knowing something without specific contextual details and the semantic gist of the list (Brainerd and Reyna, 2002). Recollection and familiarity- or gist-based retrieval are qualitatively different processes subserved by different neural structures (Sauvage et al., 2008), and recently it has been shown by functional neuroimaging that TM and FM retrieval in the DRM paradigm are mediated by different neural mechanisms (Kim and Cabeza, 2007). Specifically, highly confident TM recognitions are supported by the medial temporal lobe, a structure that has been related to recollection, whereas highly confident FM recognition engage frontoparietal regions, which are thought to mediate familiarity-based memory retrieval (Kim and Cabeza, 2007).

Importantly for the present investigation, this tendency to produce FM shows marked stable individual differences across time (Blair et al., 2002; Watson et al., 2005). Age-related differences across the lifespan in FM have also been associated with differences in brain activation (Dennis et al., 2008; Paz-Alonso et al., 2008). In children, age-related increases in TM are associated with changes in the medial temporal lobe (MTL), whereas increases in FM are related with activation changes in ventrolateral prefrontal cortex (Paz-Alonso et al., 2008). In older adults, TM recognition leads to weaker activity in the hippocampus compared with young controls, whereas FM is associated with increased activity in the left middle temporal gyrus, a region involved in semantic processing and semantic gist (Dennis et al., 2008).

In the present investigation, we asked whether individual differences in TM/FM retrieval may be related to differences in the organization of white matter connections [defined as per fractional anisotropy (FA) values derived from diffusion tensor magnetic resonance images (Le Bihan, 2003)]. To the extent to which

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* L.F. and E.C. contributed equally to this work.

Correspondence should be addressed to Antoni Rodriguez-Fornells, Departament de Ciències Fisiològiques II, Campus de Bellvitge, University of Barcelona, Institut d’Investigació Biomèdica de Bellvitge, Feixa Llarga s/n, 08907 L’Hospitalet de Llobregat (Barcelona), Spain. E-mail: antoni.rodriguez@icrea.es.

L. Fuentemilla’s present address: Institute of Cognitive Neuroscience, University College London, London WC1N 3AR, UK.

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