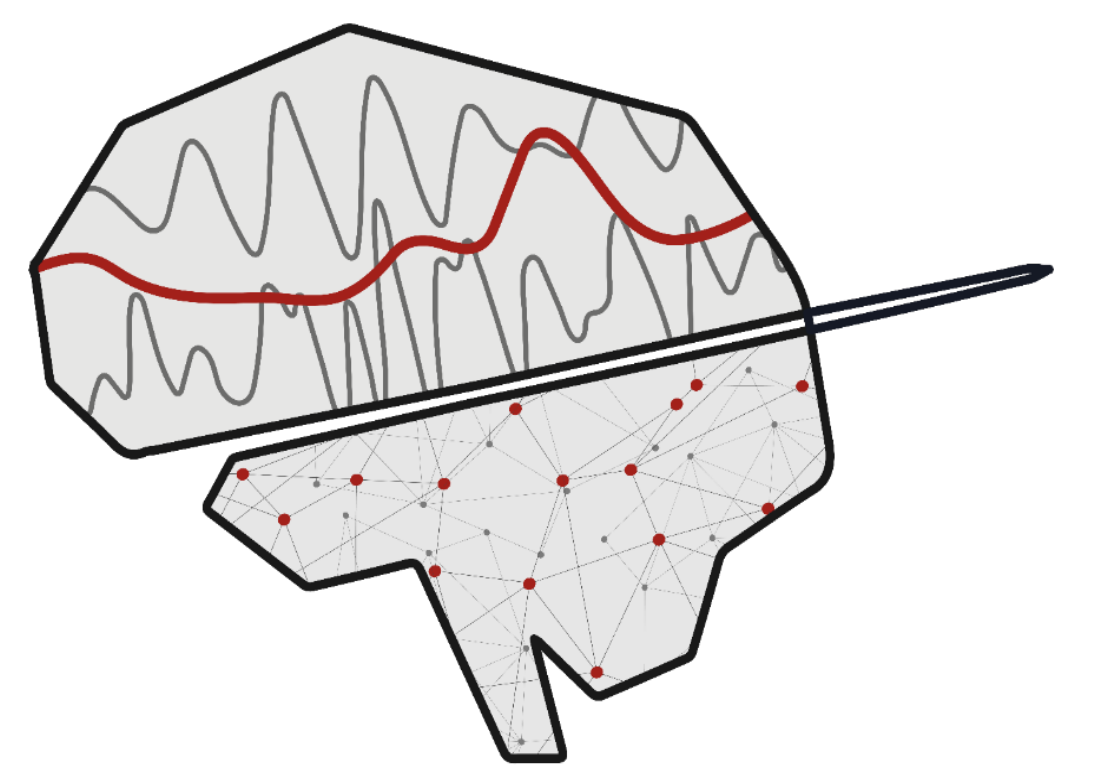




# The consistency of electrophysiological evidence for retrieval mode in episodic memory: A meta-analysis

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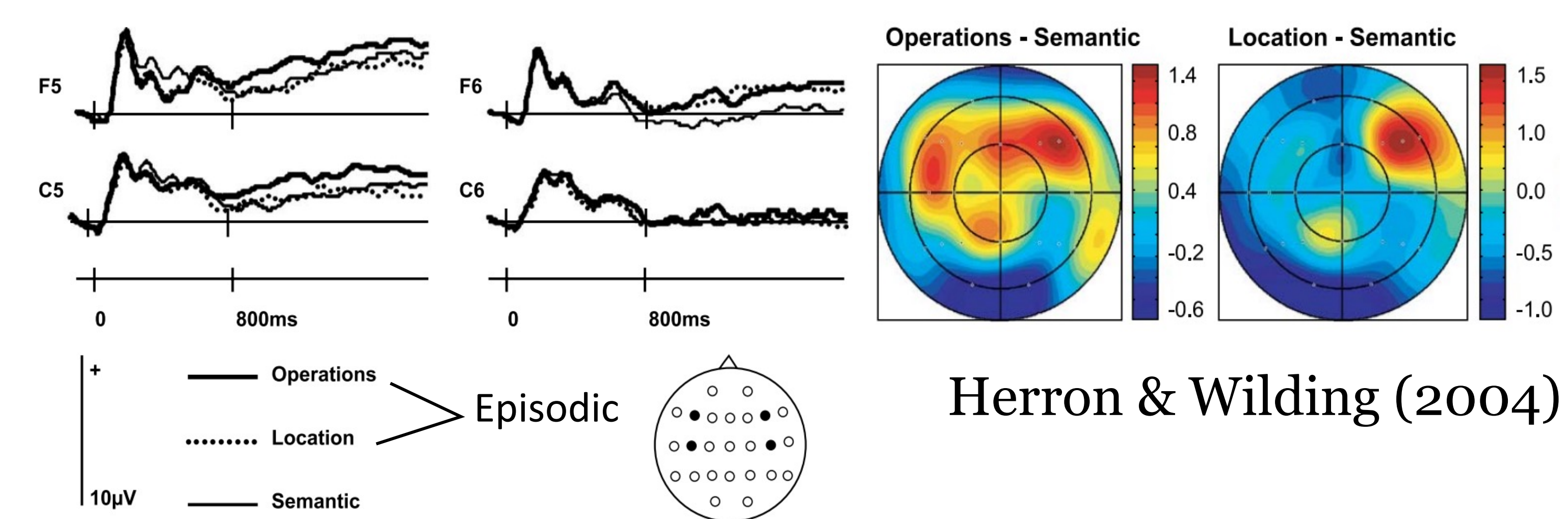
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## Background

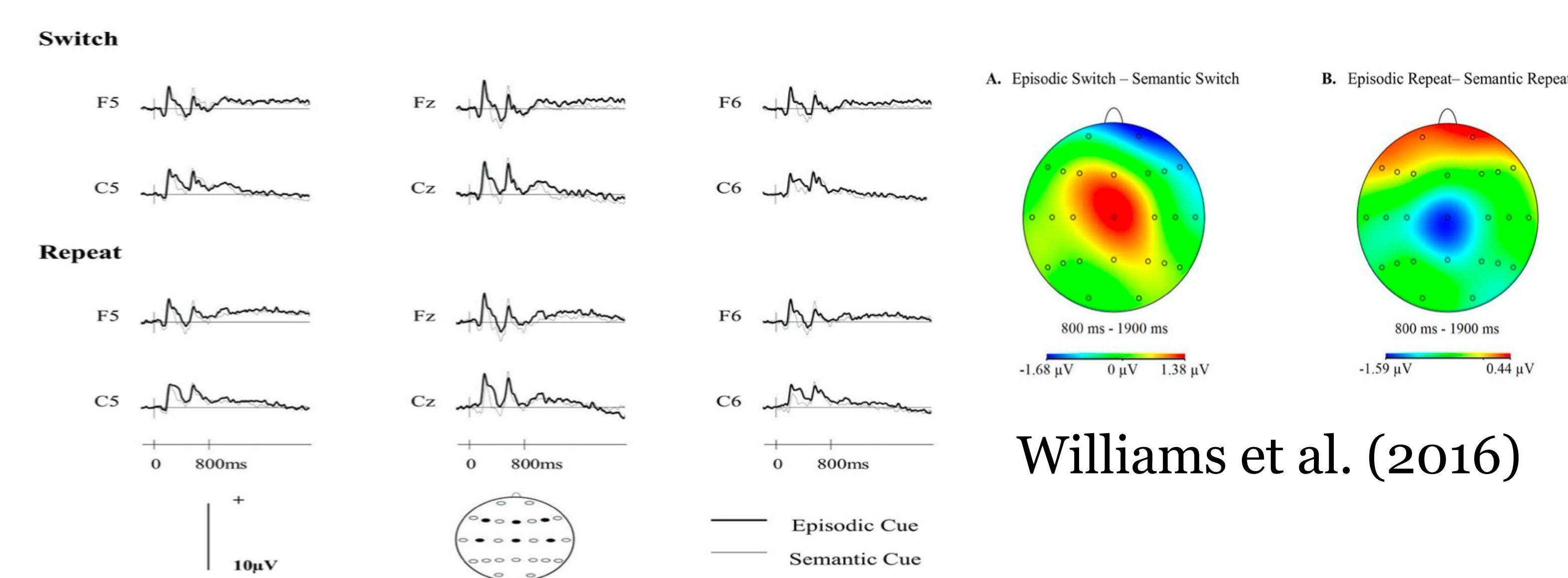
Disruptions in long-term memory can coincide with, and sometimes preclude, a variety of cognitive disorders often associated with healthy aging and psychopathology. These deficits can take multiple forms, such that they not only reflect the simple loss of mnemonic information but can also be related to a wider range of problems with cognitive control and decision making.

The current project investigates the cognitive and neural basis of **retrieval mode** - a strategically-oriented cognitive state that supports episodic retrieval by allowing the rememberer to use stimuli as cues for episodic memories (Tulving, 1983).

Neural support for retrieval mode predominantly comes in the form of an encephalographic (EEG) measure known as event-related potentials (ERPs). In studies acquiring ERPs, the retrieval mode effect is commonly identified by comparing a condition that requires episodic retrieval (e.g., *Did you previously encounter this stimulus?*) from a control condition that typically involves semantic memory (e.g., *Is the stimulus animate vs. inanimate?*, *Is the stimulus typically moving vs. non-moving?*). The neural difference between these two conditions is typically maximal over frontal scalp (likely originating in prefrontal cortex) and is extended in time (reflecting the slowly-changing cognitive state), as shown in the example below.



However, one outstanding issue in the existing ERP research on retrieval mode is that the evidence is somewhat inconsistent. Whereas several initial ERP studies of retrieval mode provided positive evidence for the phenomenon, some recent studies have surprisingly demonstrated convincing null effects, as shown in the example below.



To better understand these discrepancies, we conducted a meta-analysis of the retrieval mode studies that have provided ERP and corresponding behavioral measures. Our main hypothesis is that the disparate results are due to differences in difficulty between the episodic and semantic retrieval tasks employed.

## Meta-analysis methods

### Selection criteria

Published studies of retrieval mode were included in the meta-analysis based on the following criteria:

- Contains both behavioral and ERP measures. Behavioral measures take the form of accuracy (e.g., hit/false alarm rates, response times). ERPs are time-locked to cues indicating which retrieval task subjects should prepare to complete and are analyzed according to their spatial and temporal properties.
- Compares an episodic retrieval task to a semantic retrieval tasks. Episodic tasks typically require recognition memory (studied or not studied?) as well as a judgment about a more specific detail from encoding (i.e., source memory). Semantic tasks require the use of general knowledge (prior to the experimental session) but can take on a variety of forms (see results).
- Retrieval tasks are blocked separately or used in a task switching (switch/stay) design to cue subjects to the upcoming task.

### Included studies

So far, eleven studies have been identified as meeting these criteria:

- Düzel, Cabeza, Picton, Yonelinas, Scheich, Heinze, & Tulving (1999). Task-related and item-related brain processes of memory retrieval. *Proc Natl Acad Sci USA*, 96, 1794-1799.
- Düzel, Picton, Cabeza, Yonelinas, Scheich, Heinze, & Tulving (2001). Comparative electrophysiological and hemodynamic measures of neural activation during memory-retrieval. *Hum Brain Mapp*, 13, 104-123.
- Morcom & Rugg (2002). Getting ready to remember: the neural correlates of task set during recognition memory. *Neuroreport*, 13, 149-152.
- Herron & Wilding (2004). An electrophysiological dissociation of retrieval mode and retrieval orientation. *NeuroImage*, 22, 1554-1562.
- Herron & Wilding (2006a). Neural correlates of control processes engaged before and during recovery of information from episodic memory. *NeuroImage*, 30, 634-644.
- Herron & Wilding (2006b). Brain and behavioral indices of retrieval mode. *NeuroImage*, 32, 863-870.
- Evans, Williams, & Wilding (2015). Electrophysiological evidence for retrieval mode immediately after a task switch. *NeuroImage*, 108, 435-440.
- Williams, Evans, Herron, & Wilding (2016). On the antecedents of an electrophysiological signature of retrieval mode. *PLoS One*, 11, e0167574.
- Williams & Wilding (2019). On the sensitivity of event-related potentials to retrieval mode. *Brain Cogn*, 135, 103580.

In addition to characterizing the important design features of these studies (see next panel), we are currently aggregating the behavioral measures to provide converging support for our hypothesis about task difficulty.

## Preliminary results and discussion

Given the various forms the semantic retrieval task can take, the first step of our meta-analysis was to describe the corresponding task for each study. The table below displays a description of the episodic and semantic retrieval tasks for each study, alongside an indication of whether the retrieval mode (RM) ERP effect was present/absent (+/-).

Study	Episodic task	Semantic task	RM?
Düzel et al. (1999)	Old/new recognition	Animate/inanimate	+
Düzel et al. (2001)	Old/new recognition	Animate/inanimate	+
Morcom & Rugg (2002)	Old/new recognition	Animate/inanimate	+
Herron & Wilding (2004)	Source memory (location/task)	Typically moving/non-moving	+
Herron & Wilding (2006a)	Source memory (location/task)	Typically moving/non-moving	+
Herron & Wilding (2006b)	Source memory (location)	Animate/inanimate	+
Evans et al. (2015)	Source memory (location)	Typically moving/non-moving	+
Williams et al. (2016)	Source memory (location)	Typical location (indoors/outdoors/both)	-
Williams & Wilding (2019)	Source memory (location)	Typical location (indoors/outdoors/both)	-

- As shown above, there is considerable consistency among the episodic and semantic retrieval tasks employed.
- While the semantic tasks take on one of three general forms, we suspect that the “typical location” judgment used in the two most recent studies differs from the other semantic tasks in an important way. From Williams and Wilding (2019), in this task:  
*participants were to prepare to identify where the object was most commonly found: inside or outside, or both inside and outside (response: inside/outside/ both).* (p. 3)
- That is, while the earlier studies require subjects to retrieve what are likely *inherent* and simple properties of the stimuli (animate/inanimate or moving/non-moving), the typical location task is potentially more difficult and involves retrieving multiple properties.

➤ To conclude, the absence of retrieval mode effects for the Williams et al. (2016) and Williams and Wilding (2019) studies is consistent with our hypothesis that this task is relatively difficult and episodic in nature. This knowledge argues against using such tasks as an effective control condition for future studies.