

## **Mental time travel into the past and future: common and distinct neural substrates**

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Mental time travel allows humans to consciously re-experience past events as well as pre-experience possible future events. This fMRI study examined the neural regions mediating both the search and elaboration of past and future events.

Subjects were cued with a noun for 20 s and instructed to search for a past or future event within a specified time period (week, year, 5-20 years; *search* phase). Once subjects had the event in mind, they made a button press and for the remainder of the 20 s elaborated on the event (*elaboration* phase).

The conjunction of past and future event *search* revealed common engagement in left medial temporal lobe (MTL) and cuneus, right temporal pole, temporal parietal junction (TPJ) and fusiform. The *elaboration* of past and future events resulted in common activity in left MTL, bilateral medial prefrontal cortex (PFC), temporal poles, TPJ and medial parietal cortex.

Imagining future events engaged this common network more so than retrieving past events, including MTL, suggesting that pre-experiencing may involve more processing to bind disparate details into an integrated event. Additionally, future event search and elaboration uniquely engaged the right frontal pole, a region involved in prospective thinking.

Searching for past events did not uniquely engage any regions. During elaboration, however, many regions of the autobiographical memory network, including left medial PFC, MTL and medial parietal cortex, were engaged more than for future events.

Contrasts of search and elaboration showed that event *search* is associated with fusiform and occipital activity. *Elaboration* was associated with increased activity in TPJ and medial parietal regions, possibly mediating episodic imagery. Elaboration of past events was associated increased activity in right lateral PFC, which likely reflects post-retrieval processing. Further, left medial PFC, right MTL and temporal pole were differentially engaged during memory elaboration relative to search.

The striking overlap in neural regions mediating search and elaboration of past and future events is consistent with findings that amnesics exhibit deficits in both past and future thinking. These regions likely support processes involved in mental time travel both into the past and future, such as temporal consciousness and episodic imagery. However, differential activity in several regions suggests that distinct processes also contribute to the re-experiencing and pre-experiencing of personal episodes.

