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Dissociation of short- and long-term face memory: Evidence from long-term recency effects in temporal lobe epilepsy

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Abstract

We tested whether memory deficits in temporal lobe epilepsy (TLE) are better described by a single- or dual-store memory model. To this aim, we analyzed the influence of TLE and proactive interference (PI) on immediate and 24-h long-term recency effects during face recognition in 16 healthy participants and 18 right and 21 left non-surgical TLE patients. PI in healthy participants or TLE erased the long-term recency effect, but left the immediate recency effect unaffected. Although the immediate recency effect was still visible in right TLE patients, the number of detected recency items during immediate recognition was decreased in right TLE compared to left TLE. Right TLE was also related to decreased detection of pre-recency items during delayed recognition compared to left TLE, and decreased detection of pre-recency items during immediate recognition under PI. The results show that the temporal lobes are necessary for the long-term recency effect, but not for the immediate recency effect, and thus speak for a dissociation of short- and long-term memory for faces. Right TLE is related to more severe long-term memory deficits than left TLE and is also related to additional short-term memory deficits for faces.

Keywords: Proactive interference; Serial position effect; Single-store model; Dual-store model; Short-term memory (STM); Long-term memory (LTM); Face recognition; Immediate; Delayed; End-first strategy

1. Introduction

There is controversy whether memory should be conceptualized as a short- and a long-term memory store (Atkinson & Shiffrin, 1971; James, 1890; Shallice & Warrington, 1970; Talmi, Grady, Goshen-Gottstein, & Moscovitch, 2005), or as a unitary store (Bjork & Whitten, 1974; Crowder, 1993; Melton, 1963; Ranganath & Blumenfeld, 2005). One source of data for this controversy stems from the recency effect visible in serial learning (Glanzer & Cunitz, 1966; Murdock, 1962; Wright, Santiago, Sands, Kendrick, & Cook, 1985). The recency effect lies in a relatively better remembrance of the last items of a list (recency items) compared to previous items (pre-recency items). People spontaneously utilize the recency effect during free recall by naming the last items that they learned first (so called end-first strategy; Bjork & Whitten, 1974; Dalezman, 1976; Davelaar, Goshen-Gottstein, Ashkenazi, Haarmann, & Usher, 2005). The recency effect is found in immediate free recall (e.g. Glanzer & Cunitz, 1966) and recognition tasks (e.g. Neath, 1993; Wright et al., 1985) and is erased by distraction during the retention interval (Glanzer & Cunitz, 1966). This has been regarded as evidence for a dual-store model of memory, with items from the end of the list being recalled from a short-term memory store vulnerable to distraction and items from the start of the list being drawn from a more stable long-term memory store. Neuropsychological investigations backed up the dual-store interpretation of the recency effect. For example, amnesia or TLE do not impair the recency effect, but decrease remembrance of pre-recency items (Baddeley & Warrington, 1970; Hermann et al., 1996; Jones-Gotman, 1986). This was interpreted as evidence for an unimpaired

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short-term memory in these patients. However, it has been disputed that a dual-store model best explains the recency effect. When a distracting task is applied not only during the retention interval but also between each of the list items during the learning phase (a so called continuous distracter free recall paradigm), healthy participants still exhibit a recency effect (a so called long-term recency effect, e.g. Bjork & Whitten, 1974). The dual-store model would predict that the distracter task during the retention interval erases contents from the short-term memory store, and so the model cannot explain the long-term recency effect found by Bjork and Whitten. Moreover, memory models have been developed, which can describe the variance of the recency effect during immediate, delayed and continuous distracter free recall within a single-memory store. According to single-store memory models, items from the end of a list are better encoded and recognized than other items, as they are temporally or positionally more distinct (e.g. Neath, 1993) or because the temporal context cue used during retrieval is more efficient for recency (end-of-list cue) than pre-recency items (temporally defined cues; Howard & Kahana, 1999, 2002). Single-store models are also preferred over dual-store models for parsimony (Crowder, 1993; Melton, 1963).

In defense of a dual-store model, two recent studies argued that immediate and long-term recency effects depend on different cognitive processes. One study tested the influence of PI on immediate and long-term recency effects. PI occurs, when previously learned information impairs remembrance of more current material and is due to competition from related information in long-term memory during retrieval (Briggs, 1954; Wixted & Rohrer, 1993). The mentioned study found that PI leads to a normal immediate recency effect, but decreases the long-term recency effect during continuous distracter free recall (Davelaar et al., 2005). This result is at variance with the single-store model, that would predict a common influence of PI on immediate- and long-term recency effects. In addition, PI affects remembrance of pre-recency items (Craik & Birtwistle, 1971), similar to amnesia or TLE (see above). Further support for the dual-store model comes from a neuropsychological study. Similar to PI, the authors demonstrated that amnesia is related to a normal immediate recency effect, but a deficient long-term recency effect (Carlesimo, Marfia, Loasses, & Caltagirone, 1996). However, the authors could not determine which brain regions the long-term recency effect depends upon as most patients studied had widespread lesions. Interestingly, there is an inverse relation between PI and the temporal lobe memory system. While PI decreases the distinctiveness of memory items, the temporal lobe memory system limits interference between representations by separating patterns of similar representations (McClelland, McNaughton, & O'Reilly, 1995; Squire, Cohen, & Nadel, 1984). The temporal lobe is also critically involved in memory consolidation processes that take hours to days (Dudai, 2004; McGaugh, 2000). Classical studies suggested that temporal lobe lesions are related to decreased long-term but unimpaired short-term memory (Milner, 1972; Scoville & Milner, 1957). However, recent studies have disputed this view (Ranganath & Blumenfeld, 2005). It has been demonstrated that lesions in the hippocampal region decrease memory at short time intervals (Hannula, Tranel, & Cohen, 2006; Izquierdo et al., 1998; Ranganath & D'Esposito, 2001), and that the right hippocampus is involved in very early stages of face encoding, too (Crane & Milner, 2002; Kumaran & Maguire, 2006; Lee et al., 2005). These latter results suggest that temporal lobe lesions decrease memory at short and long delays and thus again support single-store memory models.

While left temporal lobe lesions lead to verbal memory deficits, right temporal lobe lesions lead to nonverbal memory deficits (Ladavas, Umilta, & Provinciali, 1979; Milner, 1975). Studies on the effect of TLE on the recency effect found that unilateral left or right temporal lobe resections negatively affected the memory of verbal (left) or nonverbal (right) pre-recency items, while the immediate recency effect stayed unaffected (Hermann et al., 1996; Jones-Gotman, 1986). This was interpreted as evidence for material specific deficits in long-term but not short-term memory in left or right TLE patients. Long-term recency effects have not been studied in TLE patients, so far. Given that the immediate recency effect alone is insufficient to theoretically distinguish short- and long-term memory as shown by long-term recency effects in healthy participants it is still unclear whether a dual-or a single-store model best describes material specific memory deficits in TLE. In comparison to verbal memory deficits in left TLE much less is known about nonverbal memory deficits in right TLE (Barr et al., 1997; McDermid Vaz, 2004). Therefore, the present study focuses on face memory as a measure of nonverbal memory. Right temporal lobe memory dysfunction is related to face recognition deficits (Barr, 1997; Bengner et al., 2006b; Chiaravalloti & Glosser, 2004; Coleshill et al., 2004; Dade & Jones-Gotman, 2001; Kelley et al., 1998; Milner, 1968; Morris, Abrahams, & Polkey, 1995; Moscovitch & McAndrews, 2002). The right temporal lobe dominance for face memory also corresponds well with a right hemispheric dominance for face perception in the fusiform face area (e.g. Kanwisher, McDermott, & Chun, 1997). Face memory can only be tested by recognition tasks, while studies on the long-term recency effect so far employed recall tests. We adapted the face recognition test to study the recency effect by taking advantage of the end-first strategy used during recall (see above; Bjork & Whitten, 1974; Dalezman, 1976; Davelaar et al., 2005). In order to simulate an end-first strategy we tested face recognition in a "forced" end-first manner such that items presented at a late position during the learning phase were presented at an early time point during recognition (see Fig. 1). So far, the definition of the long-term recency effect is mainly based on the continuous distracter free recall task (e.g. Bjork & Whitten, 1974). This task is a rather uncommon way of testing long-term memory. In the context of consolidation theory long-term memory is