

Rapid publication

Recognition memory for single items and for associations in amnesic patients

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Abstract

Recognition memory performance reflects two distinct processes or types of memory referred to as recollection and familiarity. According to theoretical claims about the two types of memory, single item and associative recognition tasks can be used as an experimental method to distinguish recollection and familiarity processes. Associative recognition decisions can be used as an index of recollection while memory for single items is mostly based on familiarity judgement. We employed this procedure to examine a possible dissociation in the memory performance of amnesic patients between spared single item and impaired associative recognition. Twelve amnesic patients, six with damage confined to the hippocampus proper, and six with damage elsewhere in the brain, were recruited for the present study. The findings showed that hippocampal amnesics exhibit relative sparing of single item learning but are consistently deficient in the learning of all kinds of between-item associations. These results are consistent with the view that hippocampal formation contributes differently to declarative tasks that require recollective or familiarity processes.

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1. Introduction

Recognition memory, i.e., judgement of the prior occurrence of what has been identified, is a fundamental manifestation of our ability to remember. A currently debated issue in the neurocognitive literature is whether recognition memory for single items (i.e., the representation of a unique event) can be dissociated from recognition memory for associations between items (i.e., the specific conjunctions of events unique to particular experiences).

According to the dual-process model of recognition (Mandler, 1980), recognition memory has two different bases. One of these processes involves what is known as contextual retrieval and requires recollection of the episodic context in which the item was encoded. The other process involves the feeling of familiarity, when increased fluent processing of a stimulus is attributed to recent experience of that stimulus (Jacoby & Dallas, 1981; Mandler, 1980). Critical for the purpose of the present investigation is the hypothesis that recollection and familiarity processes are

differently involved in single item and associative recognition. Indeed, while memory for single items would be principally based on familiarity judgement, independent of the retrieval of the spatio-temporal context of the experience, associative recognition decisions would be mainly based on a recall-like or recollective retrieval process (Yonelinas, 2002). For example, using the remember-know procedure (Tulving, 1985), Honckley and Consoli (1999) showed that associative recognition decisions were accompanied by more “remember” responses and less “know” responses than item recognition decisions, thus suggesting that recollection plays a more decisive role in associative than in single item recognition.

Aggleton and Brown (1999) suggested a neurobiological basis for the recollection/familiarity distinction. Based on a wide review of animal studies and on a meta-analysis of published data on amnesic patients (Aggleton & Shaw, 1996), these authors proposed that the hippocampus proper (i.e., CA fields, dentate gyrus and subiculum) is decisive for recollection but not necessary for item familiarity. Instead, item familiarity depends critically on the integrity of the cortex adjacent to the hippocampus, namely, the perirhinal, the entorhinal and parahippocampal cortices in the parahippocampal gyrus. Several convergent findings

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have supported this hypothesis, including neuropsychological evidence of a more severe deficit in recollection than familiarity in amnesic patients with hippocampal damage (Aggleton & Shaw, 1996; Mayes, Van Eijk, & Isaac, 1995; Verfaellie & Treadwell, 1993; Yonelinas, 1997), lesion and electrophysiological studies in animals (Eichenbaum, 2000) and neuroimaging studies in healthy humans (Eldridge, Knowlton, Furmanski, Bookheimer, & Engel, 2000; Yonelinas, Hopfinger, Buonocore, Kroll, & Baynes, 2001). Consistent with the hypothesis of a differential role of recollection and familiarity in memory for single items and between-item associations, this view also predicts that amnesics with neurobiological damage restricted to the hippocampus proper will have relatively spared memory for single items and that their memory for associations will be invariably impaired. Support for this prediction comes from a number of recent reports showing relatively poorer performance of hippocampal amnesics on associative than on single item recognition memory tests (Mayes, Holdstock, Isaac, Hunkin, & Roberts, 2002; Mayes et al., 2001; Vargha-Khadem et al., 1997).

The hypothesis of a differential role of hippocampal and parahippocampal regions in memory for single items and for between-item associations has been further specified on the basis of evidence that in some cases selective hippocampal damage does not impair all kinds of associative memories. Vargha-Khadem et al. (1997) found that early hippocampal sufferance in childhood impairs the recognition of associations between items with different formats (e.g., face-voice and object-place associations) but spares the recognition of individual items (e.g., single faces and words) and the recognition of associations between the same kinds of items (e.g., word-word or face-face associations). Mayes et al. (2001) also reported the case of an adult amnesic patient, YR, with bilateral hippocampal atrophy, who showed normal associative recognition of word or face pairs but failed in the recognition when a word and a face formed the pair. Based on these findings, the suggestion has been made that hippocampal damage disrupts memory for cross-region associations, i.e., associations between information represented in distinct cortical regions, but spares memory for single items and memory for within-region associations, i.e., associations between information stored in the same cortical region.

Experimental evidence is not, however, invariably consistent with the hypothesis of a differential role of hippocampal and parahippocampal regions in memory for single items and associations. The results of a recent investigation carried out by Stark and colleagues (Stark, Bayley, & Squire, 2002) are particularly critical in this regard. These authors tested controls and amnesic patients with bilateral hippocampal atrophy in both single item (i.e., faces or houses) and associative (i.e., face-house pairs) recognition tasks. In the first experiment, following a single exposure (4 s) to both single item and associative stimuli, both amnesics and controls performed more poorly on the associative than on the single item task. However, the amnesics were impaired

overall relative to the controls. In the second experiment, with additional presentation of stimuli (eight times), the amnesics' performance was improved and matched that of the controls on both single item and associative tasks. Based on these results, Stark et al. (2002) proposed the alternative view that the hippocampal region combines and extends the information processing carried out by the parahippocampal structures and that it is not more involved in memory for associations than for single items. Squire and colleagues interpreted the discrepancy of the findings in the literature as an expression of the different severity of memory disorders in amnesic patients participating in various studies. In the opinion of these authors, single item recognition is easier than recognition of between-item associations. As a result, patients with milder forms of amnesia, such as those reported by Vargha-Khadem and Mayes, may show a dissociation between normal performance on single item and poor performance on associative recognition tasks. Instead, patients with more severe amnesia (such as those reported by Stark et al.) may not show such a dissociation since the memory deficit affects both single item and associative recognition.

The three aims of the present study were to investigate: (1) whether there is a dissociation between spared recognition memory for single items and impaired recognition memory for the associations between items in patients with anterograde amnesia (particularly in patients with hippocampal damage); (2) whether there is a further dissociation in these patients between normal recognition memory for within-region associations (e.g., face-face) and deficient recognition memory for cross-region associations (e.g., face-word); and (3) whether there is a relationship between the involvement of recognition memory for single items (and possibly of within-region associations) and severity of the memory deficit in amnesic patients.

2. Materials and method

2.1. Subjects

Twelve amnesic patients (8 men and 4 women) and 12 control subjects participated in the experiment. The first group consisted of patients with memory impairment subtended by various aetiologies. Strictly behavioural and neuropsychological criteria were adopted to select patients for this group. In particular, all of these patients were referred to our laboratory because of impairment in recalling day-to-day events. Their neuropsychological evaluation showed a severe long-term episodic memory deficit in the context of substantially preserved general cognition.

Based on clinical history and results of the neuroradiological investigation, patients in the amnesic group could be classified according to the locus of neuropathological damage likely responsible for the memory disorder. Five patients had bilateral atrophy of the hippocampus. Three of them (RT, AR and TE) developed amnesia following cerebral hypoxia.

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