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Autobiographical memory in depression: An fMRI study

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ABSTRACT

Depression is associated with three distinct alterations in memory functioning: mood-congruent recall, overgenerality, and intrusive memories. These concern the autobiographical memory system, yet no previous studies have examined the neural correlates of autobiographical memory function in depression. In the present study we used functional magnetic resonance imaging (fMRI) to assess depressed and control participants during an autobiographical memory task. In their first visit to the laboratory, participants wrote a narrative account of a distressing event. Participants were scanned during the second visit while they viewed old items from their narrative and new words or phrases in a recognition memory task. Activity common to both groups during the successful identification of personal emotional memories was observed in regions previously associated with autobiographical memory retrieval. Reduced activity in the depressed group was observed in three regions of the prefrontal cortex associated with cognitive, emotional, and memory inhibition. These results are consistent with a failure by depressed individuals to inhibit task-irrelevant information during an autobiographical memory task.

1. Introduction

Three distinct alterations in autobiographical memory functioning have been extensively investigated in depression: mood-congruent recall (Blaney, 1986), overgenerality (Williams et al., 2007), and the repeated intrusion of distressing memories (Brewin et al., 2010). There is evidence that these processes are involved in the maintenance of depressive episodes (Brewin et al., 1999; Williams et al., 2007), and autobiographical memory disturbances are now being specifically addressed by innovative psychological therapies (Brewin et al., 2009; Raes et al., 2009). Despite the important function that autobiographical memory serves in depression, little is known about its neural basis. This study investigates differences between depressed patients and healthy controls in neural responses during the performance of an autobiographical memory task.

A number of reviews have indicated that autobiographical memory (AM) retrieval in healthy individuals is associated with activity in the hippocampus, parahippocampal gyrus, lateral temporal cortices, temporo-parietal junction, lateral and medial prefrontal cortex, thalamus, and cerebellum (Maguire, 2001; Gilboa, 2004; Svoboda et al., 2006; Cabeza and St Jacques, 2007; McDermott et al., 2009). In a recent meta-analysis of neuroimaging studies of memory, McDermott et al. directly compare autobiographical memory with laboratory-based episodic memory and find that the neuroanatomical regions involved are largely non-overlapping, although they observe some intersection in left inferior frontal cortex, posterior cingulate, and right thalamus. They attribute the relative lack of overlap to substantial differences in the nature of laboratory-episodic and autobiographical tasks.

To our knowledge, this is the first study to investigate the neural correlates of autobiographical memory in depression. Depressed and control participants visited our laboratory twice. At the first visit they wrote a first-person narrative of an extremely distressing event. At the second visit they completed a recognition memory task during functional magnetic resonance imaging (fMRI) using stimuli culled from their narrative which allowed us to test (i) activity common to both groups during identification of distressing autobiographical memories; and (ii) activity specific to depressed individuals during identification of such memories. Based on previous depression memory research (Hamilton and Gotlib, 2008), we anticipated greater amygdala activation in depressed patients than controls. Based on previous emotion regulation research relevant to the avoidance and suppression of emotion (Davidson et al., 2002; Aron et al., 2004; Ochsner et al., 2004; Ochsner and Gross, 2005; Koenigs and Grafman, 2009), we also predicted that depressed patients would show altered levels of activity in a number of left and right prefrontal regions.

2. Materials and methods

Data for this study were collected as part of a larger investigation into autobiographical memory systems in post-traumatic stress disorder (PTSD). All procedures were approved by the National Hospital for

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Neurology and Neurosurgery & Institute of Neurology Joint Research Ethics Committee. All patients gave written informed consent.

2.1. Participants

Thirty participants took part in this study. They were recruited through advertisements in primary care practices in London, and through advertisements around the university campus. Participants were assessed using the Structured Clinical Interview for DSM-IV (SCID-IV: First et al., 1997) by a postdoctoral research psychologist under the supervision of a clinical psychologist. Fifteen depressed, and 15 control participants were screened to ensure that they had never met criteria for PTSD, but other comorbidities were not assessed. Depressed participants met criteria for current major depression, but information about previous episodes was not gathered. Participants were additionally selected on the basis of their experiencing a distressing event that they would be willing to discuss. Inclusion criteria were that participants must be aged between 18 and 60, right-handed, with no history of head trauma. Exclusion criteria included drug and alcohol abuse, psychotic symptoms, and claustrophobia or other impediments that would prohibit examination in fMRI. Patients taking medication for depression were not excluded from the study.

2.2. Stimuli

Stimuli for the neuroimaging phase consisted of words and short phrases selected from narrative accounts of each participant's distressing events. Participants visited the laboratory before the day of the scan and were asked to write a first-person account of their distressing event, starting from just before they knew something was wrong until the point where the event had resolved. Participants were prompted to include description of what they could see, hear, touch smell, taste, and feel at each stage of the incident, and also to describe their thoughts and emotions. For participants who reported multiple distressing experiences, the chosen event was the one that bothered them most. If not enough material was judged to have been obtained from a narrative, a participant was invited either to go over sections of an event in more detail or to write a narrative of another distressing experience. Two types of task (words vs. sentences) were included in the study to maximise the range of stimuli generated by the participants that could be used without directly repeating items.

In the neuroimaging phase of the experiment, participants were presented with words and sentences from their own narrative, which were interspersed with control words and sentences from another distressing narrative thematically unrelated to their own. Two 'master lists' were generated to serve as control stimuli. Both detailed the experiences of participants suffering from PTSD who had been tested during the pilot phase of the study. One participant had survived the 7 July 2005 London bombings, and the other had survived the December 2004 Asian Tsunami. If a participant being tested had experienced one of these events, then the alternative list was used. Certain words such as 'blood' or 'helpless' were common to many narratives, and words on the master list were substituted out on a case-by-case basis whenever overlap was identified.

Seventy-two key words descriptive of each participant's experience were isolated from the narrative. The items in lists were chosen to be descriptive of key components of the narratives: when there were too many words to choose from, those that seemed incidental to the description were removed first. First-person word descriptions of the event were also preferentially chosen over post-hoc analysis of how the participant felt. If participants made spelling errors, the misspelt word was used as spelt by the participant. Each participant's list was matched to the 'master lists' on variables of word frequency, number of letters per word, and number of syllables per word.

Sixty sentences or phrases (typically 2–8 words long) were isolated from each participant's narrative. These phrases were chosen to contain key descriptions of events in each narrative. Each participant's list of phrases was matched with the 'master lists' on the following variables: number of words per sentence, and number of letters per sentence (examples of master list items are given in supplementary materials Table S4).

2.3. Procedure

Participants completed a test of recognition memory while undergoing fMRI. Stimuli were presented via a mirror mounted on the head coil of the scanner, in direct view of the supine participant, at a distance of approximately 50 cm from the projection screen. Participants used an MR-compatible button-box in their right hand to respond and were instructed to respond as quickly and accurately as possible.

Participants completed two runs of data collection. For both tasks the presentation of an item was preceded by an asterisk (*) for 500 ms, followed by the item (1000 ms in task 1, 1700 ms in task 2), followed by a fixation cross (1000 ms in task 1, and 2000 ms in task 2). These sequences of events gave stimulus-onset asynchronies (SOAs) for tasks 1 and 2 of 3500 ms and 4200 ms, respectively. 'Null events' consisted of a fixation cross presented for an entire SOA. Task timings are represented in Fig. 1.

In task 1 words were presented in the centre of the screen in uppercase 40-pt. Arial font. The participant's task was to identify whether a particular word came from the participant's own narrative or from the narrative of another participant (OWN/ELSE). This type of cue-word task has previously been used in neuroimaging studies of autobiographical retrieval (Conway et al., 1999). Seventy-two of the participants' own words were used and 72 words were presented from one of the master lists. Seventy-two null-events were included whereby a fixation cross was presented for an entire SOA.

Task 2 was identical in structure to task 1 except that sentences were used instead of words, and the SOA of each trial was lengthened to accommodate time for additional reading. Sentences were presented in lowercase 30-pt. Arial font. Participants had to identify whether a particular sentence came from their narrative or from the narrative of another participant (OWN/ELSE). Sixty of the participant's own sentences were used along with 60 from the master list. This type of task has previously been used in studies of autobiographical memory retrieval (Maguire and Mummery, 1999; Maguire, 2001; Maguire et al., 2001; Maguire and Frith, 2003).

After the scan participants were given lists of all the stimuli they had seen during the test and were asked to rate each item on separate 7-point Likert scales measuring valence and arousal. The valence scale was bounded by the terms Unpleasant (1) to Pleasant (7). The arousal scale was bounded by the terms low arousal (1) to high arousal (7).

2.4. Data acquisition and analysis

Magnetic resonance imaging (MRI) data were acquired on a 1.5 T whole body scanner (Magnetom Sonata, Siemens Medical, Erlangen, Germany) operated with an eight-channel phased array receive coil and the standard body transmit coil. The manufacturer's standard automatic 3D-shim procedure was performed at the beginning of each experiment. The participants were scanned with a single-shot gradient-echo EPI (echoplanar imaging) sequence sensitive to the blood-oxygen level dependent (BOLD) effect using the following imaging parameters: 30 oblique transverse slices, slice thickness = 2.5 mm, gap between slices = 1.25 mm, repetition time (TR) = 3 s, flip ... time (TE) = 50 ms, readout bandwidth (BW) = 2298 Hz/pixel, bandwidth in phase-encoding (PE) direction BW_{PE} = 31.3 Hz/pixel, PE direction anterior-posterior, field of view (FOV) = 192 × 192 mm^2, matrix size 64 × 64, fat suppression. The imaging volume covered nearly the whole brain with the exception of the vertex and superior parietal lobe. BOLD sensitivity losses