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Heightened false memory: A long-term sequela of severe closed head injury☆

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Abstract

Declarative memory impairment is a common long-term sequela of severe closed head injury (CHI). Although veridical memory performance following severe CHI has received attention in the literature, little is known about false memory production in this population. Within the present study, both long-term survivors of severe CHI and matched control participants studied and were tested on six 12-items word lists from the Deese Roediger McDermott (DRM) paradigm. Word lists from the DRM are composed of words that are strongly semantically associated to a non-presented word (i.e., the critical lure). Prior studies have shown that healthy young adults show a high level of false recall and recognition memory for the critical lures, and it was hypothesized individuals with severe CHI would show heightened susceptibility to false memory compared to control participants due to difficulty with monitoring of memory. It was further hypothesized that severe CHI participants would show high confidence in their false memories. Consistent with hypotheses, results indicated that although severe CHI participants remembered fewer actual list items, they made more semantically related intrusion errors (recall) and false-positive responses (recognition) than the control participants. Severe CHI participants also showed greater confidence in their false memories than did control participants. The results are interpreted in the context of theoretical accounts of false memory, and possible structural and functional brain changes that might account for the Severe CHI group's memory performance are discussed.

Keywords: Closed head injury; Traumatic brain injury; Memory; False memory

1. Introduction

Declarative memory difficulties are common sequelae of closed head injury (Baddeley, Sunderland, Watts, & Wilson, 1987; Levin, 1990; Levin, Goldstein, High, & Eisenberg, 1988; Zec et al., 2001). Encoding of novel information, consolidation of memories into long-term storage, and strategic retrieval of stored memories are all deleteriously affected subsequent to severe closed head injury (CHI). These difficulties persist in the years following the injury and often do not fully resolve (Levin et al., 1988; Zec et al., 2001). Furthermore, severe CHI survivors are often unaware of the extent, or sometimes, the presence of their memory deficits (Port, Willmott, & Charlton, 2002; Prigatano & Schacter, 1991).

Survivors of severe CHI are not only unaware of omission errors in memory, but in some cases they unwittingly make commission errors, verbally reporting inaccurate recollections that they believe to be factual (Boake, Freeland, Ringholz, Nance, & Edwards, 1995; Demery, Hanlon, & Bauer, 2001). Although spontaneous confabulation does not typically constitute the most clinically obvious long-term sequela of severe CHI (Box, Laing, & Kopelman, 1999; Demery et al., 2001; Stuss, Alexander, Lieberman, & Levine, 1978), some research indicates that brain-injured individuals are susceptible to more subtle false memory reports. Little investigation has focused on the conditions under which severe CHI survivors are prone to intrusion errors. However, a great deal of empirical work has examined false memory in healthy adults and the knowledge gained and methods used in this literature can be extended to the study of severe CHI.

Subtle errors of commission sometimes occur without awareness in neurologically intact individuals, putatively due to

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the reconstructive nature of memory (Johnson & Raye, 2000; Moscovitch & Melo, 1997; Schacter, 2000). During episodic retrieval, some features of a memory are readily brought into awareness in a relatively unambiguous fashion. However, retrieval of other features of that particular memory may be less clear due to conflation with memories from other, similar events (Roediger & McDermott, 2000) or a mismatch of the goals and contextual information present at encoding versus retrieval (Johnson & Raye, 2000). Therefore, monitoring of activated information in memory is a necessary and critical aspect of accurate memory retrieval. When monitoring of retrieval is difficult, superfluous pieces of information may be included in a memory, resulting in confabulation or intrusion errors (DeLuca, 2000).

Monitoring of memory retrieval is challenging when many specific features are shared between two experiences or pieces of information in memory (Roediger & McDermott, 2000). In instances in which memorial representations share many features, individuals may recall the general similarities or the "gist" that is common to the experiences (Brainerd & Reyna, 1998; Johnson & Raye, 2000; Loftus, 1993; Reyna & Brainerd, 1998; Roediger & McDermott, 2000). However, the item-specific features that distinguish one past experience from another may not be retrieved. The tendency to retrieve general similarities and disregard item-specific information has been termed the "relatedness effect" (Roediger & McDermott, 2000).

A great deal of research on false memory in the context of list learning has employed the Deese Roediger McDermott (DRM) paradigm, a task that exploits the relatedness effect, inducing participants to falsely recall and recognize words that were not presented (Roediger & McDermott, 2000). In this paradigm, participants are orally presented with a list of semantically associated words that are each strongly related to a non-presented word termed the "critical lure." When neurologically intact college students are administered these lists of items, non-presented critical lures are endorsed at recall and recognition at a level close to that of the presented words. Furthermore, individuals report as much confidence in these false memories as they do in their accurate recollection.

There has been little systematic investigation of the degree to which severe CHI survivors demonstrate false memories and the conditions under which these individuals are particularly susceptible to these memory commission errors. However, severe CHI survivors often demonstrate difficulty with self-monitoring of memory, particularly under interference conditions where source attributions are more difficult to make (Kennedy, 2001). Because of this memory monitoring difficulty, the severe CHI survivors are likely to rely heavily on "gist" memory when pieces of information to be remembered share numerous features. In other words, individuals with this retrieval monitoring impairment have difficulty determining whether recollected items were truly studied at encoding or if recollected items only seem to be recollected because they are strongly related to studied items. This would lead severe CHI survivors to be more prone to false memory than their neurologically healthy counterparts within the context of a memory task such as the DRM.

The present study makes use of the DRM paradigm, incorporating both recall and recognition measures to investigate reconstructive memory processes and confidence in false memory following severe CHI. Consistent with prior findings in the literature (Roediger & McDermott, 1995), control participants were expected to demonstrate the "false memory effect," thus, reporting recall and recognition for non-presented semantic associates on the DRM task. Furthermore, control participants were expected to report high confidence in their false memories. This work is guided by the hypothesis that individuals with severe CHI would not only endorse fewer actual items from the word lists, but they would also be more prone to false memory for semantic associates. This hypothesis assumes that severe CHI participants are able to develop gist memory, but have difficulty with source monitoring of memory. However, a competing hypothesis is that severe CHI participants have compromised ability to recollect specific items in memory as well as an inability to recollect gist representations. If this is true, then severe CHI participants should show compromised veridical memory and attenuated false memory for semantic associates.

2. Methods

2.1. Participants

Twenty individuals who sustained a severe CHI and 20 neurologically intact control participants participated in this study. Descriptive statistics for the two groups can be found in Table 1. All participants ranged in age from 18 to 50 years. Exclusion criteria for all participants included history of seizures, shunt placement for relief of hydrocephalus, other non-injury induced neurologic impairment (e.g., tumor, cerebrovascular accident), treatment for substance abuse, or visual or auditory difficulties that prevented the individuals from seeing or hearing stimuli presented to them. An additional exclusion criterion for the Control group was a history of a head injury in which they had experience loss of consciousness or any alteration of consciousness. Individuals with severe CHI could not participate if they had incurred more than one head injuries.

All severe CHI participants were recruited from several sources including: a support group sponsored by the Brain Injury Association of the Mid South, and the Brain Injury Associations in Nashville, TN and Little Rock, AR. The criteria for establishing the occurrence of a severe CHI was duration of post-traumatic amnesia (PTA) of 7 days or greater (Russell & Smith, 1961) and coma duration exceeding 24 h (Richardson, 1990). The duration of PTA was assessed retrospectively by means of a careful clinical interview with the survivors and a family member. The interview was similar to that employed in a study showing a high correlation between prospective Galveston Orientation and Amnesia Test ratings of PTA (Levin, O'Donnell, & Grossman, 1979) and retrospective PTA ratings (McMillan, Jongen, & Greenwood, 1996). Within the Severe CHI group, reported duration of PTA ranged from 14 to 112 days ($M = 59.60$, S.D. = 29.61). Reports of coma duration ranged from 2 days to 2 months ($M = 32$ days, S.D. = 21.34). Time since injury ranged from 14 to 108 months ($M = 43.50$, S.D. = 26.72). The Severe CHI group was not significantly different in age than the Control group, $t(38) = -1.59$, $p = 0.12$. The Severe CHI

Table 1
Descriptive data for the severe CHI and control participants

	Severe CHI	Control
Age (years)	28.8 (7.3)	25.4 (5.7)
Education (years)	13.2 (1.8)	13.5 (1.3)
PTA duration (days)	59.6 (29.6)	N/A
Time since injury (months)	43.5 (26.7)	N/A

Note: CHI: closed head injury; PTA: post-traumatic amnesia.