Relationship between confabulation and measures of memory and executive function

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Relationship Between Confabulation and Measures of Memory and Executive Function*

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ABSTRACT

Confabulation has traditionally been attributed to a combination of memory impairment and executive dysfunction, but recent models propose that confabulation can result from executive dysfunction alone. One hundred and ten patients with diverse neurologic and psychiatric diagnoses were subdivided into high-, low-, and non-confabulator groups based upon the ratio of confabulations to total responses produced during story recall. Consistent with the combined deficit model, high-confabulators performed significantly worse than the low- and non-confabulators on measures of memory and measures of executive function that assess sustained attention, mental tracking, and set-shifting ability. However, there were no differences between groups on measures of problem-solving, concept formation, and verbal fluency, suggesting a dissociation in executive functions that contribute to confabulation.

In a series of articles published in the late 19th century, Korsakoff (1889, 1955) described an unusual behavioral disturbance in which patients would verbally produce erroneous recollections that they believed were correct. This behavioral anomaly was labeled confabulation by Kraepelin (Koehler & Jacoby, 1978). Although confabulation is considered pathognomonic of Wernicke-Korsakoff’s syndrome, it has been observed in many other neurologic syndromes. In his original articles on the subject, Korsakoff (1889, 1955) described confabulation in patients with carbon monoxide poisoning, lead poisoning, and bacterial infection. More recently, it has been observed in patients with Alzheimer’s disease (AD; Kern, van Gorp, Cummings, Brown, & Osato, 1992; Mercer, Wapner, Gardner, & Benson, 1977); anterior communicating artery (ACoA) aneurysms (DeLuca & Cicerone, 1991; Fischer, Alexander, D’Esposito, & Otto, 1995; Moscovitch, 1989); hydrocephalus (Gustafson & Hagberg, 1978); stroke, and head injury (Shapiro, Alexander, Gardner, & Mercer, 1981; Stuss, Alexander, Lieberman, & Levine, 1978).

Korsakoff (1889, 1955) described a continuum of confabulation based upon severity, but Kraepelin (1904, 1907, 1919) proposed two subtypes of confabulation that presumably resulted from different etiologies. “Simple” confabulations were defined as minor distortions in fact, time, or detail whereas “fantastic” confabulations were described as bizarre, florid, exaggerated, or implausible verbalizations (Kraepelin, 1904, 1907, 1919). Although the terms “provoked” and “spontaneous” have supplanted simple and fantastic in the literature, the distinction between them has remained essentially unchanged across time and found some support in the literature (e.g., Berlyne, 1972; Kopelman, 1987; Schneider, von Däniken, & Gutbrod, 1996). However, the various terms and definitions applied in the literature and their associated theoretical models have contributed to the confusion regarding confabulation (Talland, 1987).

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1961; Whitlock, 1981). It has yet to be determined whether provoked and spontaneous confabulations are two distinct phenomena with different etiologies (e.g., Berlyne, 1972; Kopelman, 1987, Schnider, von Däniken, & Gutbrod, 1996) or if they represent the extreme ends of a continuum (e.g., DeLuca & Cicerone, 1991; Shapiro et al., 1981). In addition, the precise mechanisms involved in the production of confabulation have yet to be adequately characterized.

Korsakoff described confabulation as a “peculiar form of amnesia” (1889, 1955) and the notion that it is primarily a disturbance in memory has predominated since that time (e.g., Berlyne, 1972; Kaplan & Sadock, 1991). However, both Korsakoff (1889, 1955) and Kraepelin (1904) recognized long ago that confabulation was uncommon and that memory impairment alone was insufficient for confabulation. In recent years, frontal lobe damage and impairments in executive function have been linked to confabulation (e.g., Baddeley & Wilson, 1988; Benson et al., 1996; Benson & Stuss, 1990; Damasio, Graff-Radford, Eslinger, Damasio, & Kassell, 1985; DeLuca, 1993; DeLuca & Cicerone, 1991; DeLuca & Diamond, 1995; Fischer et al., 1995; Johnson, 1991; Johnson, Hashtroudi, & Lindsay, 1993; Joseph, 1986; Kern et al., 1992; Mercer et al., 1977; Moscovitch, 1989; Shapiro et al., 1981; Stuss et al., 1978).

Two models of confabulation have been proposed differing primarily in the extent to which memory impairment contributes to confabulation. The first model asserts that confabulation results from a combination of memory impairment and executive dysfunction (Baddeley & Wilson, 1988; Damasio et al., 1985; DeLuca, 1993; DeLuca & Cicerone, 1991; DeLuca & Diamond, 1995; Fischer et al., 1995; Kern et al., 1992; Mercer et al., 1977; Moscovitch, 1989; Shapiro et al., 1981; Stuss et al., 1978). This combined deficit model has been supported by several individual case and group studies. For example, Baddeley and Wilson (1988) described an amnestic patient with frontal lobe damage who confabulated. Stuss et al. (1978) observed confabulation in patients with memory impairment and self-monitoring deficits. Mercer et al.'s (1977) confabulating patients presented with impaired memory and problems inhibiting incorrect responses, monitoring responses, or recognizing environmental cues. Confabulation has also been observed in patients with AD (Kern et al., 1992; Korsakoff, 1889, 1955) and ACoA aneurysms (DeLuca, 1993; Fischer et al., 1995), two patient groups that evidence executive dysfunction and memory impairment.

The second model hypothesizes that confabulation results solely from executive dysfunction, more specifically disinhibition and deficits in self-monitoring (Benson et al., 1996; Benson & Stuss, 1990; Johnson, 1991; Johnson et al., 1993; Joseph, 1986). Accordingly, confabulation can occur in the absence of an amnestic syndrome although memory deficits may increase confabulatory behavior. It has been observed clinically that confabulation decreases over time without significant change or reduction in memory disturbance in patients with Korsakoff’s disease (Benson et al., 1996; Korsakoff, 1889, 1955), ACoA aneurysms (DeLuca, 1993), and AD (Kern et al., 1992, Korsakoff, 1889, 1955). Benson et al. (1996) described a patient whose confabulation decreased with improvements in executive function (based on neuropsychological testing) and frontal lobe function (based upon functional imaging), but with no significant change in memory function during the same period of time. The patients described above in the study of Mercer et al. (1977) were amnestic, but there was no observed relationship between severity of memory impairment and confabulation. Although confabulation does not occur in all patients with executive dysfunction, the above clinical and research findings suggest a correlation between confabulation and executive dysfunction. However, these same findings also raise questions regarding the causal influence attributed to memory impairment in the production of confabulation.

The present group study was designed to compare memory and executive function in confabulating and nonconfabulating patients using standardized neuropsychological measures. As noted previously by Kern et al. (1992) and Moscovitch (1989), the existing literature is largely based upon single cases or series of
cases and is primarily anecdotal or descriptive. In addition, those few studies employing standardized neuropsychological measures to assess related cognitive functions have mostly been qualitative in nature due to the small sample sizes (e.g., Damasio et al., 1985; DeLuca, 1993; Stuss et al., 1978). Therefore, a large patient sample was utilized for this study to allow for statistical comparisons between groups. Modeling the research of Kopelman (1987) and Kern et al. (1992), systematic and objective criteria were established for differentiating confabulatory from nonconfabulatory behavior in prose form. Confabulation ratios were computed to control for variability in amount of responding and standardized neuropsychological measures were employed to assess and compare different aspects of cognitive function and their relationship to confabulation.

A secondary goal of this study was to determine the association between confabulation and measures of intrusions on list learning tasks. Previous studies (e.g., Bigler, Rosa, Schultz, Hall, & Harris, 1989; DeLuca, 1993; Fischer et al., 1995) have noted that confabulating patients evidence more intrusion errors in recall and false positives in recognition on word-list learning tests. Accordingly, confabulating and non-confabulating patients were compared in regard to number and ratio of intrusions and false positives on a standardized measure of word-list learning.

METHOD

Participants

One hundred and ten patients seen for a comprehensive evaluation by the neuropsychology service at a major Midwestern medical center were included in this archival study. Medical charts from a 2-year period were screened and only those patients to whom both the Wechsler Memory Scale and the California Verbal Learning Test had been administered were reviewed. Exclusionary criteria for all participants included the following: (a) less than eight years of education, (b) impairments in language function, (c) the presence of a delirium or confusional state, or (d) an estimated premorbid Full Scale Intelligence Quotient (FSIQ) less than 70 (based upon the National Adult Reading Test (NART); Nelson, 1982; Nelson & O’Connell, 1978). Due to constraints of existing data sets, not all participants completed all neuropsychological measures.

Seventy-two (65.5%) participants were Caucasian, 34 (30.9%) were African American, and 4 (3.6%) were Hispanic. Fifty-two (47.3%) were male and 58 (52.7%) were female. For the sample, mean age was 47.59 years (SD = 17.52), mean educational level was 13.48 years (SD = 2.94), and mean estimated FSIQ was 100.50 (SD = 13.42). The different diagnostic groups comprising the sample are presented in Table 1.

Confabulation groups

The participants were assigned to one of three groups (nonconfabulators, low-confabulators, and high-confabulators) based upon their responses to a standardized test of memory. The logical memory (LM) subtest of the Wechsler Memory Scale (WMS, Wechsler, 1945) with Russell’s (1975; 1988) adaptation was utilized to assess confabulation in prose form. Previous studies demonstrated that confabulating patients provide intrusions on immediate and delayed recall of the WMS LM (DeLuca, 1993; Kern et al., 1992; Kopelman, 1987). In addition, the use of a standardized test of memory controls for prior learning and participant exposure to stimuli and provides a validated scoring system. For this study, the scoring criteria of Schwartz and Ivnik (1980) was employed to identify correct and incorrect responses on immediate and delayed recall.

Kern et al.’s (1992) methodology was utilized for differentiating confabulations (novel intrusions) from normal errors on the WMS LM. Recall inaccuracies were defined as responses that were categorically correct in regard to content, but inaccurate in regard to detail. Any responses that were semantically and phonemically related to the stories were also considered recall inaccuracies and not included in confabulation totals. Confabulations were defined as responses that were categorically, semantically, and phonemically unrelated to the original passage. A confabulation total was obtained by tabulating the number of confabulations provided during WMS LM immediate and delayed recall. Due to variability in the amount of responding (Kern et al., 1992), a confabulation ratio was computed for each participant by dividing their confabulation total by their total number of responses (correct responses, recall inaccuracies, confabulations).

METHOD
Table 1. Primary Diagnoses.

<table>
<thead>
<tr>
<th>Diagnostic Group</th>
<th>Total Sample</th>
<th>Confabulators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Non</td>
</tr>
<tr>
<td>Cerebrovascular Accident</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Traumatic Brain Injury</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Dementia(^a)</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Tumor</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Psychiatric Disorder(^b)</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>Other(^c)</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>25</td>
</tr>
</tbody>
</table>

Note. \(^a\) Alzheimer’s Disease = 9; HIV/AIDS = 2; Multiple Sclerosis = 2; Parkinson’s Disease = 1; Encephalitis = 1; \(^b\) Depression = 12; Schizophrenia = 4; Anxiety Disorder = 3; Alcohol/Substance Abuse = 3; Psychiatric Disorder NOS = 3; \(^c\) Systemic Lupus Erythematosus = 4; Korsakoff’s Disease = 3; Narcolepsy = 1; Organic Mental Disorder NOS = 4.

Participants were divided into groups based upon their confabulation ratios utilizing the sample mean (\(M = 0.09\)) and standard deviation (\(SD = 0.10\)). The nonconfabulator group (confabulation ratio \(= 0.0; n = 25\)) included those participants who did not provide any novel intrusions on the WMS LM. The low-confabulator ratios (range = 0.01-0.19; \(n = 70\)) were within one standard deviation of the mean. The high-confabulator ratios (range = 0.20-0.86; \(n = 15\)) were greater than one standard deviation above the mean. The different diagnostic groups that comprise the subgroups are presented in Table 1.

Executive Function Measures
Several measures were included in the present study to test different aspects of executive function. The Wisconsin Card Sorting Test (WCST) was administered and scored according to Heaton, Chelune, Talley, Kay, and Curtiss, (1993). Percent perseverative errors and number of categories completed on the WCST were included to assess concept formation and problem-solving ability (Arnett et al., 1994; Heaton et al., 1993; Milner, 1963). The Controlled Oral Word Association Test (COWAT) was administered and scored according to Benton and Hamsher (1989). Total number of words generated was used as a measure of verbal fluency or spontaneity (Benton & Hamsher; Lafleche & Albert, 1995; Stuss & Benson, 1984). The Stroop Test (Stroop, 1935), with the color, word, and color-word trials, was administered and scored according to Golden (1978). Scores on the three 45-s trials were employed as indices of attention, mental tracking, interference, and freedom from distractibility (Benson et al., 1996; Golden, 1978; Hanes, Andrews, Smith, & Pantelis, 1996; MacLeod, 1991). The Trail Making Test was administered and scored according to Reitan and Wolfson (1986). Total time (s) on Part A was included as a measure of attention and psychomotor speed and time on Part B was included to assess sustained attention, mental tracking, and set-shifting ability (Benson et al., 1996; Lafleche & Albert, 1995; Reitan & Wolfson, 1993; Vanderploeg, Schinka, & Retzlaff, 1994). A proportional score was computed (Part B minus Part A) to control for the effect of psychomotor slowing.

Memory Measures
Performances on memory measures can differ in the amount of attention, organization, and effort required (DeLuca, 1993; Fischer et al., 1995; Mangels, Gershberg, Shimamura, & Knight, 1996; Moscovitch, 1989; Shimamura & Jurica, 1994; Stuss & Benson, 1984). For example, free recall and learning tests are more demanding and require greater effort than cued recall and recognition tasks (Crosson, Novack, Trerrey, & Craigslist, 1988; Millis & Ricker, 1994; Troyer, Fisk, Archibald, Ritvo, & Murray, 1996; Vanderploeg et al., 1994). The California Verbal Learning Test (CVLT) was administered and scored according to Delis, Kramer, Kaplan, and Ober (1987) and several indices were selected that varied in the effort required. In regard to more effortful processing, total words
recalled on trials 1–5 was used to assess rate of learning and short- and long-delay free recall were included to measure strategic retrieval ability. Number of words produced on short- and long-delay cued recall and number of recognition hits on the recognition subtest of the CVLT were included as measures of less effortful memory. Russell’s (1975, 1988) adaptation of the WMS visual reproduction (VR; Wechsler, 1945) with immediate and delayed recall was also included to assess memory function outside the verbal domain.

**Intrusion Measures**

Previous studies have suggested that confabulating patients provide more false positives on recognition tests and intrusions on free recall during list learning tasks (Bigler et al., 1989; DeLuca, 1993; Fischer et al., 1995). Therefore, total intrusions on the CVLT were tabulated from free and cued recall measures following short- and long-delays. An intrusion ratio was also computed by dividing total intrusions by the number of responses (correct responses and intrusions) provided by each participant. Total number of false positives was obtained from the recognition subtest of the CVLT. In addition, the discriminability score was included to account for differences in the number of responses provided by each participant.

**Statistics**

Demographic variables and test results were compared across confabulation groups by one-way analysis of variance (ANOVA). Due to the number of memory and executive function measures to be compared, a more stringent alpha level ($\alpha = .001$) was adopted to reduce the possibility of Type I error. With significant ANOVA results, post hoc Scheffé tests were performed between groups. A chi-square analysis was also performed to identify any systematic differences in confabulation ratios related to diagnosis.

### RESULTS

#### Demographics

Demographic variables were compared across confabulation groups by ANOVA (Table 2). No significant differences were identified for age ($F(2,107) = .02, p = .98$), education ($F(2,107) = .08, p = .92$), or estimated FSIQ ($F(2,107) = 1.21, p = .30$). In addition, chi-square analysis revealed no significant differences ($p > .05$) between the observed and expected distribution of participants within the diagnostic categories. As there were no significant differences between groups in regard to demographic variables, the raw neuropsychological test results and intrusion scores were then compared by ANOVA. With the exception of the Trail Making Test (Part A, Part B, and B-A) times and WCST percent perseverative errors, lower raw scores on the executive function and memory measures in Tables 3 and 4, respectively, indicate poorer performances. In contrast, higher raw intrusion scores in Table 5 indicate poorer performances, with the exception of the CVLT discriminability score.

#### Executive Function Measures

Table 3 presents the results of the executive function measures. There were no significant differences identified between groups by ANOVA on WCST percent perseverative errors, WCST categories, or COWAT. In addition, no significant differences were found on the Stroop color and word trials. Although the Stroop color-word group differences was not significant at the $p \leq .01$ level, there was a trend ($F(2, 72) = 3.68, p = .03$) towards lower scores for the high-
Table 3. Executive Function Test Results by Group.

<table>
<thead>
<tr>
<th></th>
<th>Non-Confabulators</th>
<th>Low-Confabulators</th>
<th>High-Confabulators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>(SD)</td>
</tr>
<tr>
<td>Stroop Color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroop Word</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroop Color-Word</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trail Making Test, Part A (s)</td>
<td>23</td>
<td>47.88</td>
<td>(32.71)</td>
</tr>
<tr>
<td>Trail Making Test, Part B (s)</td>
<td>23</td>
<td>121.25*</td>
<td>(94.85)</td>
</tr>
<tr>
<td>COWAT</td>
<td>20</td>
<td>36.25</td>
<td>(9.61)</td>
</tr>
<tr>
<td>WCST Categories</td>
<td>25</td>
<td>3.96</td>
<td>(2.15)</td>
</tr>
<tr>
<td>WCST Percent Perseverative Error</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. WCST = Wisconsin Card Sorting Test; COWAT = Controlled Oral Word Association Test. Means with same superscript letters are significantly different from each other (p ≤ .05).

confabulator group as compared to the nonconfabulator and low-confabulator groups. One-way ANOVAs revealed significant differences on the Trail Making Test, Part A [F(2,96) = 4.81, p = .01] and Trail Making Test, Part B [F(2,96) = 4.57, p = .01]. Post hoc (Scheffé tests) analyses revealed that the high-confabulator group was significantly slower on the Trail Making Test, Part A than the low-confabulator group and significantly slower on the Trail Making Test, Part B than both the nonconfabulator and low-confabulator groups. Although not significant at the p ≤ .01 level, there was a trend [F(2,96) = 3.05, p = .05] towards worse proportional performances on the Trail Making Test, B-A by the high-confabulator group as compared to the nonconfabulator and low-confabulator groups. No significant differences in performance were found between the nonconfabulator and low-confabulator groups on any of the executive function measures.

Memory Measures
The results of the memory measures are presented in Table 4. Although not significant, there were trends towards significant group differences on CVLT short-delay free recall [F(2,107) = 2.80, p = .07] and WMS VR imme-

Table 4. Memory Test Results by Group.

<table>
<thead>
<tr>
<th></th>
<th>Non-Confabulators</th>
<th>Low-Confabulators</th>
<th>High-Confabulators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>(SD)</td>
</tr>
<tr>
<td>CVLT Total Words Trials 1-5</td>
<td>25</td>
<td>40.72*</td>
<td>(14.37)</td>
</tr>
<tr>
<td>CVLT Short-Delay Free Recall</td>
<td>25</td>
<td>6.96</td>
<td>(4.95)</td>
</tr>
<tr>
<td>CVLT Long-Delay Free Recall</td>
<td>25</td>
<td>7.00*</td>
<td>(5.10)</td>
</tr>
<tr>
<td>CVLT Short-Delay Cued Recall</td>
<td>25</td>
<td>8.36*</td>
<td>(4.45)</td>
</tr>
<tr>
<td>CVLT Long-Delay Cued Recall</td>
<td>25</td>
<td>8.32*</td>
<td>(4.58)</td>
</tr>
<tr>
<td>CVLT Recognition Hits</td>
<td>25</td>
<td>12.80</td>
<td>(3.49)</td>
</tr>
<tr>
<td>WMS VR Immediate Recall</td>
<td>25</td>
<td>7.16</td>
<td>(2.87)</td>
</tr>
<tr>
<td>WMS VR Delayed Recall</td>
<td>25</td>
<td>5.40</td>
<td>(3.33)</td>
</tr>
</tbody>
</table>

Note. CVLT = California Verbal Learning Test; WMS VR = Wechsler Memory Scale Visual Reproduction. Means with same superscript letters are significantly different from each other (p ≤ .05).
The results of the present study indicate that confabulation is significantly related to impaired memory. Confabulation ratios corresponded to performances on the majority of verbal and non-verbal memory measures with the high-confabulator group performing significantly worse than the low-confabulator and non-confabulator groups. The data also suggest a relationship between confabulation and some aspects of executive function. The high-confabulator group performed significantly worse than the low- and non-confabulator groups on measures of sustained attention, set-shifting, and mental tracking. These findings cannot be accounted for by differences in speed of processing alone. In contrast, performances on measures of concept formation, problem-solving, and verbal fluency did not differ between the

**DISCUSSION**

The results of the present study indicate that confabulation is significantly related to impaired memory. Confabulation ratios corresponded to performances on the majority of verbal and non-verbal memory measures with the high-confabulator group performing significantly worse than the low-confabulator and non-confabulator groups. The data also suggest a relationship between confabulation and some aspects of executive function. The high-confabulator group performed significantly worse than the low- and non-confabulator groups on measures of sustained attention, set-shifting, and mental tracking. These findings cannot be accounted for by differences in speed of processing alone. In contrast, performances on measures of concept formation, problem-solving, and verbal fluency did not differ between the
high-, low-, and non-confabulator groups. In regard to intrusion measures, there were no significant differences between groups in the number of recall intrusions, but the high-confabulator group provided a significantly larger ratio of intrusions as compared to the low- and non-confabulator groups. Additionally, there were no significant differences in the number of false positives, but there was a trend towards a worse performance by the high-confabulator group on the recognition discrimination as compared to the low- and non-confabulator groups.

The above findings provide support for the combined deficit model of confabulation rather than the executive dysfunction model. In contrast to the executive dysfunction model, the combined deficit model proposes that there must be memory impairment for confabulation to occur. Consistent with this proposal, the high-confabulator group performed significantly worse than the low- and non-confabulator groups on measures of verbal and nonverbal memory. These results suggest that regardless of the measure employed, domain assessed, or amount of effort involved, memory impairment is more prevalent in patients who confabulate.

Both confabulation models propose that a deficit in executive function is necessary and this is supported by the finding of impaired performances on measures of sustained attention, set-shifting, and mental tracking ability supports. It is noteworthy, however, that no differences were found between groups in regard to concept formation, problem-solving, or verbal fluency. This dissociation of deficits in confabulating patients is consistent with the dissociation found between impairments resulting from orbitofrontal and dorsolateral prefrontal damage (Cummings, 1993; Stuss & Benson, 1984; Trimble, 1990). Along with confabulation, orbitofrontal and basal forebrain lesions have been associated with attentional problems, impulsivity, and impairments in self-monitoring (Benson et al., 1996; Damasio et al., 1985; DeLuca, 1993; DeLuca & Cicerone, 1991; Fischer et al., 1995; Stuss & Benson, 1984), suggesting that the underlying cognitive processes and neuroanatomical systems are related.

The results indicate that the proportion of novel recall intrusions to total responses on a list learning task can be used as an index of confabulation. Although numerous recall intrusions have been reported in individual cases or small group studies (e.g., Bigler et al., 1989; DeLuca, 1993; Fischer et al., 1995), there were no statistically significant differences in the number of intrusions provided by the high-, low-, and non-confabulator groups in this study. These findings indicate that rather than the actual number, it is the relative number of intrusions in list learning or story recall as compared to the total number of responses that differentiates confabulating patients. In addition, there were no significant differences between the nonconfabulator group and the low-confabulator group on any of the neuropsychological tests or intrusion measures. This suggests that the presence of some intrusions in story recall is normal provided that a large number of responses were given.

Two advantages of the present study, as compared to previous research in confabulation, were the utilization of standardized neuropsychological measures and the incorporation of a large patient sample with diverse diagnoses. These improvements allow for statistical comparisons between groups and greater generalization of results. Consistent with previous case studies demonstrating confabulation resulting from diverse etiologies, there were no systematic differences in the ratios of confabulation associated with the various diagnostic groups. Although the quantification of confabulation is a strength of this study, it also represents a limitation in that it prevents the analysis of qualitative or subtype differences (i.e., provoked vs. spontaneous). As noted earlier, different subtypes of confabulation have been hypothesized to result from different etiologies (Schnider, von Däniken, & Gutbrod, 1996) and grouping all confabulators together may obscure subtle cognitive differences between them. In addition, confabulatory responses produced in story recall may be qualitatively different from both provoked and spontaneous confabulation in a clinical setting. Further research may benefit from qualitative analyses of responses and the isolation of subtypes.
This study was also limited by a lack of neuroradiological information for the participants. Although inferences can be made regarding the neuroanatomical substrates involved in confabulation, the exact relationship between frontal lesions and impaired performances on measures of executive function remains controversial (e.g., Anderson, Bigler, & Blatter, 1995; Anderson, Damasio, Jones, & Tanel, 1991; Horner, Flashman, Freides, Epstein, & Bakay, 1996). Therefore, no definitive conclusions about the association between different frontal lesions and confabulation can be drawn from the present study. Additional research with imaging data is needed to delineate the cortical structures involved in confabulation.

In conclusion, the results of the present study provide support for the combined deficit model of confabulation with co-morbid impairments evident in both memory and aspects of executive function. The findings also suggest that confabulation results from any general neurologic disturbance that produces defects in memory and executive function, rather than a specific pathology or neurologic disorder. However, the dissociation in performances on measures of executive function indicates that attention, mental tracking, and set-shifting abilities are more closely related to confabulation than are problem-solving, concept formation, and verbal fluency.

REFERENCES


