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Intrusions and provoked and spontaneous confabulations on memory tests in Korsakoff's syndrome

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ABSTRACT

Introduction: Intrusions on verbal memory tests have been used as an index for clinical confabulation. Severe memory impairments in combination with executive dysfunction have been suggested to be the underlying mechanism of confabulation, but to date, this relation is unclear. The aim of this study was (a) to examine the relation between (different types of) intrusions and confabulations in a large sample of confabulating patients with Korsakoff's syndrome (KS) and (b) to investigate whether different measures of executive functioning and memory performance are related to provoked and spontaneous confabulation. *Method*: The Dutch version of the California Verbal Learning Test (CVLT) and various executive function and memory tests were administered to a group of 51 confabulating patients with KS. Professional caregivers rated the severity of provoked and spontaneous confabulation behavior of the patients using the Nijmegen–Venray Confabulation List–20 (NVCL–20). *Results*: The total number of intrusions on the CVLT was not related to either provoked or spontaneous confabulation scores. None of the CVLT intrusion scores correlated significantly with any of the confabulation scores, but we did find small-to-medium, positive correlations between unrelated intrusions and both provoked confabulations and spontaneous confabulation. Provoked confabulation behavior was associated with executive dysfunction and poorer memory performances. Spontaneous confabulation was not related to performance on measures of executive function and memory. *Conclusions*: The total number of intrusions on verbal memory tests and clinical confabulations appear to be different phenomena. Only unrelated intrusions produced on the CVLT might possibly be related to confabulations. The production of provoked, but not spontaneous, confabulation is associated with executive dysfunction and memory deficits.

Confabulations can be defined as unintentionally produced actions and statements that are incongruent with the present situation and are frequently observed in amnesic patients (Cooper, Shanks, & Venneri, 2006; Dalla Barba, 1993). Confabulation has also been referred to as "honest lying," since people who confabulate are not aware of the falseness of their statements (Moscovitch, 1995). Several distinctions between forms of confabulation have been proposed. Kopelman (1987) introduced a dichotomy that focused mainly on the evocation of confabulations as a crucial factor, and proposed to distinguish between *provoked* and

spontaneous confabulations. He stated that whereas spontaneous confabulation may result from the superimposition of frontal dysfunction on an organic amnesia, provoked confabulation may reflect a normal response to a faulty memory (Kopelman, 1987, p. 1482). More recently, Schnider (2008) argued that this dichotomy might not cover all aspects of confabulations and proposed a classification system that distinguishes four forms of confabulation: (*Simple*) *provoked* confabulations are intrusions on memory tests; *momentary* confabulations are false verbal statements produced in a discussion or a situations

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eliciting a person to respond; *behaviorally spontaneous* confabulations emphasize the combination of confusion in reality and acting upon these false ideas, which occurs in patients with amnesia and disorientation. Finally, fantastic confabulations have no basis in reality and are implausible (Schnider, 2008).

Provoked confabulations can occur in many diseases (even in healthy people) and do not seem to have a specific anatomical basis (Schnider, 2008). In patient groups, they have often been linked with amnesia, which is consistent with Kopelman's (1987) description of provoked confabulations. However, conflicting results have been found in studies correlating provoked confabulations with neuropsychological measures of memory. Some studies demonstrated significant positive relations between provoked confabulations (i.e., intrusions on the California Verbal Learning Test; CVLT: Delis, Kramer, Kaplan, & Ober, 1987) and memory performance (on the CLVT; Kopelman, 1987; Schnider, von Daniken, & Gutbrod, 1996). Other studies did not find significant correlations between measures of memory and provoked confabulations (Kapur & Coughlan, 1980; Schnider, von Daniken, & Gutbrod, 1997). Therefore, Schnider (2008; Schnider et al., 1996) concluded that provoked confabulations are not reliably associated with the degree of amnesia. However, provoked confabulations have mostly been measured by the number of intrusions on word-list learning tasks. Examination of the relation between provoked confabulation and measures of memory functioning may be informative when using measures better suited to examine provoked confabulation, such as the Provoked Confabulation Test (Cooper et al., 2006) or the Nijmegen–Venray Confabulation List–20 (NVCL–20; Rensen et al., 2015).

Several mechanisms have been proposed to underlie spontaneous confabulation behavior. One theoretical account suggests that temporal context confusion might set spontaneously confabulating patients apart from nonconfabulating amnesic patients (Dalla Barba, Nedjam, & Dubois, 1999; Schnider & Ptak, 1999; Schnider, Ptak, von Daniken, & Remonda, 2000). This might result from an inability to suppress previously activated, but currently irrelevant, memory traces that may guide their behavior. For example, spontaneous confabulators show problems with recognizing the temporal order of stored information (Schnider et al., 1996). Another hypothesis is that spontaneous confabulations may arise from executive dysfunction in addition to severe memory impairments (Burgess & McNeil, 1999; Fischer, Alexander, D'Esposito, & Otto, 1995; Kapur & Coughlan, 1980; Stuss, Alexander, Lieberman, & Levine, 1978). Fischer et al. (1995) proposed that the extent of executive dysfunctioning, in addition to the presence of memory deficits, determines the severity of confabulating behavior. Poor strategic and monitoring capacities (Moscovitch & Melo, 1997), resulting in problems such as formulating a memory strategy, specifying appropriate cues, guiding search, and evaluating retrieved memories (Gilboa et al., 2006; Metcalf, Langdon, & Coltheart, 2010; Moscovitch & Winocur, 2002), have also been argued to result in spontaneous confabulations. In their review, Gilboa and Moscovitch (2002) noted that in 81% of 79 spontaneous confabulators the prefrontal cortex was affected. Especially damage to the ventromedial and/or oribitofrontal regions might result in spontaneous confabulation behavior (for a review, see Kopelman, 2015). Although spontaneous confabulations have been linked to frontal damage and executive dysfunction, several studies demonstrated that there was no relation between performance on executive measures and confabulation behavior (Cooper et al., 2006; Rensen et al., 2015; Schnider & Ptak, 1999; Schnider et al., 1996). The relationship between spontaneous confabulation and executive dysfunction remains unclear and has never been explored in large sample sizes.

Several studies attempted to quantify confabulation behavior using intrusions on word and story recall tasks (De Anna et al., 2008; Kopelman, 1987; Schnider et al., 1996). However, the relation between memory intrusions and confabulation behavior has not clearly been established. So far, studies failed to find significant correlations between intrusions produced on the CVLT and provoked or spontaneous confabulations as determined by clinical reports, confabulation batteries, or observation scales (Kessels, Kortrijk, Wester, & Nys, 2008; Nahum, Bouzerda-Wahlen, Guggisberg, Ptak, & Schnider, 2012; Rensen et al., 2015). The results from these studies indicate that intrusions and confabulations might represent dissociated phenomena, possibly with different underlying cognitive mechanisms. In addition, results from studies by Gilboa et al. (2006) and Kan, LaRocque, Lafleche, Coslett, and Verfaellie (2010) showed that the *type* of intrusions, rather than the total *number* of intrusions, distinguishes confabulators from nonconfabulating groups. Specifically,

false recall and recognition of semantically unrelated words (e.g., idiosyncratic errors, implausible lures) distinguishes confabulating patients from nonconfabulating patients. In contrast, only examining the total number of intrusions might obscure this relation, possibly explaining the nonsignificant correlations found in previous studies. In the present study, we examined the relation between (different types of) intrusions and provoked and spontaneous confabulation scores, and extended the work of Gilboa et al. (2006) and Kan et al. (2010) in a relatively large sample of Korsakoff patients, who are known for the production of confabulations.

Our first aim was to examine the relation between (different types of) intrusions and confabulations. We (a) examined whether the total number of intrusions on the CVLT was related to provoked and spontaneous confabulations on the NVCL–20; on the basis of previous reports, we expected to find no significant relations (Kessels et al., 2008; Nahum et al., 2012; Rensen et al., 2015); and (b) we examined whether different types of intrusions (semantically related errors, semantically unrelated errors, proactive interference, and retroactive interference) were related to different forms of confabulations. Based on the findings by Gilboa et al. (2006) and Kan et al. (2010), we expected to find a relation between all confabulation behavior and semantically unrelated intrusions. Moreover, we hypothesized that proactive and retroactive interference measures reflect an inability to suppress previously activated, but currently irrelevant, memory traces and might be related to spontaneous confabulations. Therefore, a significant correlation between interference scores and spontaneous confabulations was expected. Our second aim was to investigate whether different measures of executive functioning and memory performance were related to provoked and spontaneous confabulation. Spontaneous confabulations are often thought to arise from memory and executive problems. However, only limited evidence exists supporting this important role of executive control. Also, provoked confabulations have been related to memory deficits.

Method

Participants

We included 51 patients with Korsakoff's syndrome (43 men; M_{age} = 58.6 years, range = 44–75). All patients met the criteria for *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM–5*; American Psychiatric Association, APA, 2013) alcohol-induced major neurocognitive disorder, as established by neurological, psychiatric, neuroradiological, and neuropsychological examinations. In addition, the criteria for alcoholic Korsakoff's syndrome had to be met: A history of malnutrition or thiamine deficit with evidence of a history of Wernicke encephalopathy, and a disproportionate memory disorder (Kopelman, Thomson, Guerrini, & Marshall, 2009). The disproportionate memory disorder was reflected in the performance of all patients on the CVLT: A total of 98.1% of the participants were impaired (i.e., more than 1.5 standard deviations of the mean) on their overall performance on Trials 1–5, and 94.2% of the participants showed rapid forgetting after delayed testing as compared to a representative norm group. None of the patients had any evidence of other brain pathology that could account for their condition.

Diagnoses were established by a multidisciplinary expert team. All participants were recruited from the Centre of Excellence for Korsakoff and Alcohol-Related Cognitive Disorders of the Vincent van Gogh Institute for Psychiatry in Venray, the Netherlands. Patients' family and medical records provided background information (including drinking history). All patients were abstinent from alcohol at the time of testing (Korsakoff: M_{days} = 101.2, *SD* = 83.9). Prior to the study, patients gave their informed consent, and all procedures were approved by the local ethics committee. Participant characteristics are presented in Table 1.

Materials

California Verbal Learning Test

The Dutch version of the California Verbal Learning Test (CVLT; Mulder, Dekker, & Dekker, 1996) was administered to all participants. Internal consistency of this test is good (Cronbach's α = .87, *SE* = 2.9; as reported in Mulder et al., 1996, and interpreted based on the guidelines as proposed by George & Mallery, 2003). The predictive validity, examined with discriminant analyses in Mulder et al. (1996), is also good. Mulder et al. demonstrated that the overall performance on Trials 1–5, the short-delay recall, and the long-delay recall were

significantly lower, and the forgetting rate was significantly higher, in patients with Korsakoff's syndrome than in a healthy control group, as was predicted (examined with Tukey-B tests, with $p \leq .005$). Administration started with the presentation of a 16-word shopping list (List A) to the participant. This shopping list contained words from four different semantic categories: herbs and spices, fruits, clothing, and tools. Immediately following presentation, the participant was asked to freely recall as many items as possible. This was repeated four more times and was followed by the presentation of an interference list (List B). After free recall of List B, the short-delay free recall and short-delay cued recall of List A were administered. After a 20-min delay period, long-delay free recall and long-delay cued recall of List A were administered. The total number of intrusions—that is, the total number of false responses when recalling words from the shopping list—was used as a dependent variable.

In addition, we distinguished between different types of intrusions, as specified in the CVLT manual (Mulder et al., 1996)—namely, semantically related and unrelated intrusions, and proactive and retroactive interference. Semantically related intrusions belonged to the semantic categories of List A, but were not presented. Unrelated intrusions were unrelated to the words of the shopping list—for example, words that are not generally on grocery lists or nonwords. The recollection of items from List A, when List B was targeted, was considered as proactive interference. The recollection of items from List B, when List A was targeted, was interpreted as retroactive interference. Semantically related and unrelated intrusions, and proactive and retroactive interference were used as dependent variables in the correlational analyses. As our aim was to examine intrusions, we only included the free- and cued-recall measures in our analyses (but not recognition performance).

Nijmegen–Venray Confabulation List–20 (NVCL–20)
The Nijmegen–Venray Confabulation List–20 (NVCL–20; Rensen et al., 2015) was completed by the first responsible caregiver of the patient. The NVCL–20 is an observation scale, consisting of 20 items covering various aspects of confabulating behavior (e.g., "*Is the content of the confabulations realistic?*" and "*Does the patient act upon his/her confabulations?*") and memory functioning.

The category scores for provoked confabulation and spontaneous confabulation were used in this study. Internal consistency, as reported in Rensen et al. (2015), was good to excellent for provoked confabulation (lambda 2 = .75) and excellent for spontaneous confabulation (lambda 2 = .91). It has been demonstrated that Korsakoff patients who confabulated on the NVCL–20 also confabulated on the Provoked Confabulation Test (Rensen et al., 2015). Responsible caregivers of the patients encircled the answer that was most appropriate for the behavior of the patient at the time of completing the instrument. Questions were rated on the basis of a 5-point rating scale.

Measures of executive functions and memory
The neutral, congruent, and incongruent conditions of the Stroop Color Word Test (SCWT; Golden, 1978) were administered. An interference score {[Time Card 3 – (Time Card 1 + Time Card 2)]/[(Time Card 1 + Time Card 2)]} × 100 was used to examine response inhibition. The Trail Making Test from the Delis–Kaplan Executive Function System (TMT D-KEFS, the number–letter switching condition; Delis, Kaplan, & Kramer, 2001) was used to examine cognitive flexibility. The completion time in seconds was used as outcome variable. The d2 Test of Attention (Brickenkamp & Zillmer, 1998) was used, a cancellation task that is considered to be a measure of sustained attention. The concentration performance score (total number of correctly crossed out items, minus the errors of commission) and total number of processed characters (corrected for the number of errors) were used as dependent variables. The complete Behavioral Assessment of the Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996) was administered to examine executive functions in a context more relevant to daily life, and we used the BADS total profile score.

The Rivermead Behavioral Memory Test–Third Edition (RBMT–3) was administered as an ecologically valid test of everyday memory (Wester, 2014). The general memory index was used as a dependent variable. We examined the correct performance on the CVLT to measure learning and remembering of new verbal information. The total number of correctly recalled elements on Trial 5, short-delay free and cued recall, and long-delay free and cued recall were used as dependent variables.

Table 1. Participant characteristics.

Korsakoff group	Mean scores (SD)
Group demographics	
Age (years)	58.6 (8.1)
Sex distribution (male/female)	43/8
Education (code)	4 (1–7)a
Abstinence (days)	101.2 (83.9)
Neuropsychological testing	
NART-IQ (*N* = 47)	93.1 (17.6)
CVLT (*N* = 51)	
Trial 5 correct	5.7 (1.8)
Short-term free recall correct	1.3 (2.0)
Short-term cued recall correct	4.3 (2.5)
Long-term fee recall correct	1.3 (1.8)
Long-term cued recall correct	4.0 (2.4)
RBMT–3 (*N* = 49)	58.4 (4.6)
Stroop interference (*N* = 49)	129.8 (43.1)
TMT (*N* = 35)	168.3 (62.4)
d2 processed elements (*N* = 47)	301.0 (96.7)
d2 concentration performance (*N* = 47)	93.6 (49.8)
BADS (*N* = 40)	12.7 (3.1)

Note. Mean scores with standard deviations (SD) in parentheses for a sample of Korsakoff patients. Educational code: The level of formal education was assessed using seven categories, based on a Dutch classification system using a 7-point rating scale, ranging from 1 (*less than primary education*) to 7 (*university degree*). NART-IQ = National Adult Reading Test IQ (Schmand, Bakker, Saan, & Louman, 1991); CVLT = California Verbal Learning Test; RBMT–3 = Rivermead Behavioral Memory Test–3 general memory index; TMT = Trail Making Test from the Delis–Kaplan Executive Function System, D-KEFS; d2 = d2 Test of Attention; BADS = Behavioral Assessment of the Dysexecutive Syndrome total profile score.
aMedian and range are displayed.

Neuropsychological tests were administered as part of a standard neuropsychological assessment, which took place after admission of the patients to the Vincent van Gogh Institute. The total sample of Korsakoff patients completed the CVLT. Two participants did not complete the RBMT–3, two participants did not complete the Stroop Color Word Test, and four participants did not complete the d2 Test of Attention due to lack of motivation or an inability to perform the task. The TMT D-KEFS was administered in 35 participants, because this test was added to the assessment battery at a later point in time. The total profile score of the BADS could be obtained for 40 participants. The other participants did not complete all subtests of the BADS. The scores on the neuropsychological tests are presented in Table 1.

Statistical analysis

Relation between intrusions and confabulations

Spearman correlation coefficients (one-tailed) were calculated for all analyses, as our data were not normally distributed. Ratio scores (intrusions corrected for the total number of recalled elements on the CVLT) were used in the analyses, as we assumed relative scores to be a more valid indicator of the tendency to produce intrusions than raw scores. We calculated correlations between the ratio of total number of intrusions on the CVLT and provoked and spontaneous confabulation scores on the NVCL–20. To examine whether different types of intrusions were related to different types of confabulation, correlations were calculated between ratios of semantically related and unrelated intrusions, proactive interference and retroactive interference raw scores on the CVLT, and provoked and spontaneous confabulations on the NVCL–20.

Relation between confabulation, executive functioning, and memory

First, correlations were calculated between provoked and spontaneous confabulations on the NVCL–20 and the individual neuropsychological raw test scores. The SCWT interference score and TMT D-KEFS number–letter switching score were inversed (i.e., × −1), so that higher scores on neuropsychological tests always represented better performances. Second, correlations between confabulations and executive functioning compound score and a memory compound score were calculated. To construct these compound scores, we first examined the interrelationship between the neuropsychological tests. Subsequently, these executive functioning and memory variables were converted to standardized *z* scores, and, subsequently, an executive compound score and a memory compound score were calculated. Correlations were calculated to relate provoked and spontaneous confabulations on the NVCL–20 to the executive and memory compound scores.

Results

All Korsakoff patients displayed confabulation behavior on the NVCL–20. Moreover, all of the patients who produced spontaneous confabulations also produced provoked confabulations. Seven patients only produced provoked confabulations. The means and standard deviations of the confabulation scores on the NVCL–20 and intrusions on the CVLT are presented in Table 2. The total number of correctly recalled elements on Trials 1–5 of CVLT was >3 standard deviations below that of the control norm group. Moreover, the Korsakoff patients in this study showed an increased tendency (>1.5 standard deviations from the norm) to produce semantic intrusions

Table 2. Mean intrusions and confabulations in the Korsakoff group.

Intrusion and confabulation measures	Raw scores	Ratio scores
Intrusions (CVLT)		
Total recalled elements	60.3 (21.5)	
Total intrusions	18.3 (12.3)	0.3 (0.1)
Semantically related	12.2 (9.1)	0.2 (0.1)
Semantically unrelated	3.7 (5.1)	0.1 (0.1)
Proactive interference	0.6 (0.9)	0.0 (0.0)
Retroactive interference	1.8 (1.9)	0.0 (0.0)
Confabulation scores (NVCL–20)		
Spontaneous	15.7 (6.9)	
Provoked	9.5 (2.7)	

Note. NVCL–20 = Nijmegen–Venray Confabulation List–20; CVLT = California Verbal Learning Test. NVCL–20 minimum scores are not equal to 0. Minimum scores are: spontaneous confabulation = 9, provoked confabulation = 3. Standard deviations in parentheses.

on the CVLT compared with a control norm group. The production of unrelated intrusions, proactive interference, and retroactive interference was normal (mean standard deviations from the norm ranging between –1.5 and +1.5) compared to that for a norm group.

Relation between intrusions and confabulations

Correlations between (different types of) intrusions and confabulations are presented in Table 3. Correlations between the total intrusion score on the CVLT and provoked and spontaneous confabulation scores were not statistically significant. None of the CVLT intrusion scores correlated significantly with any of the confabulation scores. We did find small-to-medium, positive correlations between semantically unrelated intrusions on the CVLT and both provoked confabulations ($r_s = .20$, $p = .083$) and spontaneous confabulation ($r_s = .20$, $p = .075$) on the NVCL–20, but these correlations were not significant.

Relation between confabulation, executive functioning, and memory

Neuropsychological tests that significantly correlated with one another were used to construct the

Table 4. One-tailed Spearman correlations among provoked and spontaneous confabulations, executive functioning, and memory in Korsakoff patients.

	Confabulations	
Neuropsychological tests	Provoked	Spontaneous
Memory (compound) (N = 49)	**−.37****	−.09
CVLT Trial 5 correct (N = 51)	−.22	−.13
CVLT short-term free recall correct	**−.37****	−.11
CVLT short-term cued recall correct	−.23	−.05
CVLT long-term free recall correct	−.18	.15
CVLT long-term cued recall correct	−.22	.15
RBMT–3 (N = 49)	**−.38****	−.10
Executive functioning (compound) (N = 47)	−.23	−.04
Stroop task (N = 49)	−.23	−.14
TMT (N = 35)	.02	.12
d2 concentration performance (N = 47)	**−.30***	−.07
d2 processed elements (N = 47)	−.09	.03
BADS (N = 40)	−.26	−.12

Note. CVLT = California Verbal Learning Test; RBMT–3 = general memory index on the Rivermead Behavioral Memory Test–3; Stroop task = interference score on the Stroop Color Word Test; TMT = interference score on the Trail Making Test from the Delis–Kaplan Executive Function System, D-KEFS; d2 = d2 Test of Attention; BADS = total profile score on the Behavioral Assessment of the Dysexecutive Syndrome.
*$p < .05$. **$p < .01$.
Significant correlations ($p < .005$) are presented in bold.

compound scores. For the executive functioning composite, we found that SCWT interference, the d2 concentration performance score, and the d2 processed elements correlated significantly with one another (ranging from $r_s = .44$ to $r_s = 59$). For the memory composite score, we found that all memory measures (RBMT–3 general memory index, correct answers on CVLT Trial 5, short-delay free and cued recall, and long-delay free and cued recall) correlated significantly with one another (ranging from $r_s = .36$ to $r_s = 59$).

Correlations among provoked and spontaneous confabulations and neuropsychological test scores are presented in Table 4. We found a small-to-medium, negative correlation between the executive compound score and provoked confabulations ($r_s = −.23$, $p = .058$). There was no significant correlation between the executive compound score and spontaneous confabulations. With respect to the individual neuropsychological

Table 3. One-tailed Spearman correlations among provoked and spontaneous confabulations and ratios of intrusions in the Korsakoff group.

	CVLT				
	Intrusions			Interference	
NVCL-20	Total	Unrelated	Related	Proactive	Retroactive
NVCL–20 spontaneous confabulation	.15	.20	.11	.19	.09
NVCL–20 provoked confabulation	.17	.20	.14	−.06	−.13

Note. CVLT = California Verbal Learning Test; NVCL–20 = Nijmegen–Venray Confabulation List–20.

tests, we found negative correlations between pro-voked confabulations and SCWT interference (r_s = −.23, p = .058, small-to-medium effect), the d2 concentration performance (r_s = −.30, p = .021, medium effect), and the BADS total profile score (r_s = −.26, p = .053, small-to-medium effect). None of the executive subtests correlated with spontaneous confabulations.

We found a medium, negative correlation between the memory compound score and provoked confabulations (r_s = −.37, p = .004) in Korsakoff patients. There was no significant correlation between spontaneous confabulations and the memory compound score. Negative correlations were found between provoked confabulations and the RBMT general memory index (r_s = −.38, p = .004, medium effect), the total correct elements produced on Trial 5 of the CVLT (r_s = −.22, p = .058, small-to-medium effect), short-delay free recall condition of the CVLT (r_s = −.37, p = .004, medium effect), short-delay cued recall condition of the CVLT (r_s = −.23, p = .055, small-to-medium effect), and long-delay cued recall on the CVLT (rs = −.22, p = .058, small-to-medium effect). No significant relations were found between provoked confabulation scores and long-delay free recall. None of the memory subtests correlated with spontaneous confabulations.

Discussion

This is the first study to systematically examine the relation between (different types of) intrusions and confabulations in a large sample of confabulating patients with Korsakoff's amnesia. The two main aims of this study were (a) to examine the relation between (different types of) intrusions and confabulations in a large sample of confabulating patients with Korsakoff's syndrome and (b) to investigate whether different measures of executive functioning and memory performance are related to provoked and spontaneous confabulation. Overcoming limitations of previous studies by using standardized measures of confabulation in a large group of Korsakoff patients, we found that the results from the present study extend previous findings, as no relation between total number of intrusions on the CVLT and provoked and spontaneous confabulation scores was found (Kessels et al., 2008; Nahum et al., 2012; Rensen et al., 2015). Moreover, examining different types of intrusions suggested that intrusions are not related to confabulations, with the probable exception of unrelated intrusions. With respect to our second aim, the executive functioning and memory compound and subtests correlated significantly with provoked but not spontaneous confabulation scores. Korsakoff patients with higher provoked confabulation scores had lower scores on the executive functioning and memory measures.

Relation between intrusions and confabulations

We hypothesized that distinguishing between semantically related and unrelated intrusions and proactive and retroactive interference, instead of examining total intrusion scores, might disclose more clear relations with confabulations. We found that only unrelated intrusions might potentially be related to both provoked and spontaneous confabulations on the NVCL–20. We did not find significant relations, but the effects were small to medium. The lack of significance might have been the result of the sample size of the study. Although the sample in this study is relatively large for the population, it is relatively small for the performed tests. A larger sample would increase the power of the statistical test, possibly showing significant relations. Semantically related intrusions and confabulation scores were unrelated to confabulations. The results of this study are in line with the conclusion drawn by Gilboa et al. (2006) and Kan et al. (2010) that the production of semantically unrelated intrusions might set confabulators apart from nonconfabulating patient groups. Semantically related intrusions might be the result of intruding, highly related associations, and Kan et al. (2010) noted that these types of associations place high demands on monitoring processes. This might even be difficult for nonconfabulators. Unrelated intrusions might resemble confabulations. Future studies might replicate these findings in a larger sample of confabulating patients.

The production of semantically unrelated intrusions might be the result of an overactive associative system or an inability to determine the source of the information. It has been proposed that confabulators may overprocess task-irrelevant information (Kan et al., 2010). Hence, presentation of the CVLT word list might activate strongly associated words, such as semantically related ones (i.e., from the same categories as the words on the CVLT), but an overly active associative system might also result in activation of unrelated words.

Source monitoring theory states that confabulating patients have a tendency to misidentify imagined events as real, possibly inaccurately accepting the imagined words (Johnson, Hashtroudi, & Lindsay, 1993). As a result, imagined words (semantically related or not) might be falsely accepted as presented words. Because of impaired monitoring processes, not only the semantically related, but also the unrelated intrusions are not noticed and corrected (Gilboa et al., 2006; Kan et al., 2010). These mechanisms might also underlie confabulations.

Contrary to our expectations, we did not find significant relations between the interference scores and spontaneous confabulation (or any of the other confabulation scores). It has previously been demonstrated that confabulators fail to suppress currently irrelevant memory traces (Schnider & Ptak, 1999). We hypothesized that proactive and retroactive interference on the CVLT might reflect a failure to inhibit previously learned items from List A, when recalling items from List B (or vice versa). However, interference on memory tasks is not the same construct as confabulations. In addition, Gilboa et al. (2006) proposed that the inability to suppress currently irrelevant memory cues plays a major role in spontaneous confabulation and might be a necessary condition for spontaneous confabulation to occur; however, it is not sufficient as a single causal mechanism. Gilboa et al. proposed that temporal context confusion might be the result of a more encompassing failure to reconstruct memories.

The results of this study may have important clinical implications. Confabulation behavior is considered to be a characteristic clinical symptom of the syndrome (Borsutzky, Fujiwara, Brand, & Markowitsch, 2008). In clinical practice, the screening of confabulatory tendencies may provide supplementary information about the cognitive profile of patients with Korsakoff's syndrome and should be included in the neuropsychological examination. The results of this study indicate that only unrelated intrusions produced on the CVLT might be associated with clinical confabulations. Therefore, the clinician should focus on the production of this type of intrusion, rather than the total number of intrusions, when one wants to screen for confabulation tendencies. Moreover, when a clinician wants to quantify confabulation behavior, we suggest the use of instruments such as the Provoked Confabulation Test (Cooper et al., 2006) and the NVCL–20 (Rensen et al., 2015), which are designed to serve this purpose. As for research on

confabulations, our results indicate that the total number of intrusions on memory tests is different from clinical confabulations, and conclusions based on the examination of *total* intrusions should not be extended to (provoked) confabulations.

Relation between confabulation, executive functioning, and memory

The combination of severe memory impairments with executive dysfunction has been suggested as the underlying neurocognitive cause of confabulation, and spontaneous confabulation in particular. Interestingly, spontaneous confabulations and executive measures were unrelated in this study. In contrast, we did find relations between provoked confabulations and most of the executive measures used in this study—that is, the executive compound score, SCWT interference, d2 processed elements, and the BADS total profile score. We provide two explanations for our findings.

First, the executive measures described in this study were selected because they are commonly used to assess executive functions in clinical practice. Possibly, the standard tests of executive functions may not reveal the specific prefrontal dysfunction underlying spontaneous confabulation. Models of confabulations suggest that executive processes involved in strategic retrieval and memory monitoring might be related to confabulation (Gilboa & Moscovitch, 2002; Johnson et al., 1993; Moscovitch & Melo, 1997). It is not clear whether any of the standard tests used in this study tapped into these executive processes, which might explain the nonsignificant findings with spontaneous confabulations.

Second, we should note that we had a number of missing data points for the neuropsychological tests, in particular the tests of executive functioning. The participants with missing data might have differed in some systematic way from those with complete data. For example, for some patients data were missing for the d2 attention test because of an inability to perform the tests or lack of motivation. These patients then might have been "cognitively" worse than the patients who completed all executive tests and as a result may have demonstrated more spontaneous confabulation behavior. Exclusion of these patients in the analyses might have resulted in a different pattern of results. We suggest that future studies should replicate these results, using a fairly complete dataset.

We did not find relations between spontaneous confabulations and measures of memory functioning. However, provoked confabulations were significantly related to the compound memory score, as well as individual memory measures (RBMT–3, CVLT). That is, patients with lower memory scores produced more provoked confabulations. This is in agreement with the notion that provoked confabulations are often seen in and linked with amnesia (Schnider, 2008) and with Kopelman's (1987) description, that "provoked confabulation may represent a normal response to a faulty memory" (p. 1486). Some previous studies did not find significant correlations between measures of memory and provoked confabulations (Kapur & Coughlan, 1980; Schnider, von Daniken, & Gutbrod, 1997). However, these studies used the number of intrusions on word-list learning tasks as the provoked confabulation measure. As we have argued above, these variables may reflect different phenomena.

Limitations

With respect to the limitations of the current study, it should be noted that we performed multiple tests, which increases the probability of making a Type I error. As a result, the findings in the sample of Korsakoff patients described in this study might not reflect the actual pattern in the general population. We aimed to explore the relation between types of intrusions and different forms of confabulations, and multiple explorative correlational analyses were performed accordingly. We suggest that future studies should focus especially on the possible relation between unrelated intrusions and confabulations in confabulating patient groups. Moreover, we recommend the use of instruments, such as the Provoked Confabulation Test (Cooper et al., 2006) and the NVCL–20 (Rensen et al., 2015), to quantify confabulation behavior in research and clinical practice, instead of (types of) intrusions on memory tests. In addition, we reported relations between provoked confabulations and measures of executive functions. However, other studies failed to find significant relations between these two measures (Cooper et al., 2006; Rensen et al., 2015; Schnider & Ptak, 1999; Schnider et al., 1996). We emphasize that the results of this study should be replicated in a larger group of patients.

Second, the Korsakoff patients in the current study had a rather broad range of abstinence. It

has been demonstrated that length of abstinence might be associated with cognitive functioning in alcoholics. In non-Korsakoff alcoholics, for example, impaired cognitive functioning is widespread during the first months of abstinence, but improves over time (Fein, Bachman, Fisher, & Davenport, 1990). Moreover, improved performance on cognitive tests was related to increased length of abstinence in Korsakoff patients (Joyce & Robbins, 1993). Including patients with relatively short periods of abstinence, as was done in this study, might result in a sample of patients with more severe cognitive problems, and potentially increased confabulation behavior, compared with a sample of Korsakoff patients in a nursing home, who might be abstinent for several years. However, Walvoort, Wester, and Egger (2013) suggest that Korsakoff patients are already in a chronic, stable phase of syndrome after more than 6 weeks of abstinence (Walvoort et al., 2013). Most patients in this study, except for five, were abstinent for 6 weeks or more. Consequently, we believe that our results might be fairly representative for Korsakoff patients in a chronic state.

In order to compare samples of Korsakoff patients with respect to confabulation behavior, it might also be helpful to include a cognitive screening instrument, such as the Mini-Mental State Examination (MMSE; Folstein, Folestein, & McHugh, 1975) or Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005), so that the results can be interpreted relative to overall level of cognitive functioning.

Conclusion

We did not find a significant relation between the total number of intrusions on the CVLT and provoked or spontaneous confabulation behavior. Only unrelated intrusions might possibly be related to confabulations. Spontaneous confabulation scores were unrelated to measures of executive function and memory. However, provoked confabulation behavior was associated with executive dysfunction and poorer memory performances.

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Disclosure statement

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