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Confabulations in alcoholic Korsakoff patients

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ABSTRACT

Besides forgetting, memory is also prone to distortions, errors and illusions. Confabulation is one type of memory distortion that may occur in cases of brain damage. Although confabulations are described anecdotally in patients with alcoholic Korsakoff syndrome (KS), there are few systematic investigations of the presence and nature of these types of false memories in KS. Moreover, it is unclear whether KS patients' confabulations evenly affect all types of memories, or whether certain memory domains are more susceptible. Our study attempted to clarify two questions: first, whether confabulations are a critical feature of the cognitive impairment associated with long-term KS in a large sample of patients ($N = 42$). Second, we investigated which memory domain is most likely affected by confabulations in KS. To elicit confabulations, we used a Confabulation Interview containing questions from different memory domains. We found that KS patients overall confabulated more compared to a group of healthy subjects. Furthermore, we found that patients confabulated most within the episodic/autobiographical memory domain.

Our results imply that besides pronounced memory deficits typically associated with KS, confabulation can also be regarded as a clinical feature of the disease. The preponderance of episodic confabulation obtained here by using a standardized test, confirms anecdotic reports that KS patients confabulate in everyday life mainly with respect to their personal past and present.

Thus, for a detailed description of the memory profile of KS patients, the screening of confabulation tendencies may be a useful supplementary clinical tool.

1. Introduction

Long-term chronic alcohol abuse may lead to the so-called Wernicke–Korsakoff syndrome (WKS). While Wernicke's encephalopathy (WE) represents the 'acute' sudden-onset phase of the disorder with prevailing peripheral neurological symptoms such as ophthalmoplegia, nystagmus, ataxia, and mental confusion (Sechi & Serra, 2007; Victor, Adams, & Collins, 1989), the Korsakoff syndrome (KS) represents the 'chronic' phase of the disease (Kopelman, 1995; Victor et al., 1989). The cardinal symptom of chronic KS constitutes dense anterograde amnesia, despite relatively intact intellectual functioning. Concomitant retrograde amnesia may vary in its extent (for a review of cognitive deficits see Brand, 2007). Further prominent symptoms include temporo-spatial disorientation (Shaw & Aggleton, 1994) and emotional changes such as apathy, lack of initiative (Talland, 1965; Victor et al., 1989) or disturbances in affective processing (Brand et al., 2003; Montagne, Kessels, Wester, & de Haan, 2006; Snitz, Hellinger, & Daum, 2002). Various recent neuropsychological studies also suggest executive dysfunctions in KS patients (Brand et al., 2005; Brokate et al., 2003; Oscar-Berman, Kirkley, Gansler, & Couture, 2004). While Korsakoff himself (Korsakoff, 1891) and other early researchers (e.g. Bonhoeffer, 1901; Delay & Brion, 1969; Van der Horst, 1932) emphasised confabulations in long-term alcoholics to be a distinctive clinical feature, today's state of knowledge is rather ambiguous. Although confabulations are mentioned as a probable symptom in most of the descriptions of KS (e.g. Kopelman, 1995; Preuß & Soyka, 1997; Talland, 1965; Victor et al., 1989), systematic studies with KS patients regarding their confabulation tendencies are very rare (for e.g. Welch, Nimmerrichter, Gilliland, King, & Martin, 1997). Clinical diagnostic guidelines are similarly ambiguous: Whereas the ICD-10 (World-Health-Organization, 1994) mentions confabulations as a probable but not obligatory symptom for diagnosing an 'Alcohol-Induced Amnesic Syndrome' (F10.6), the DSM-IV (American Psychiatric Association, 1994) does not include confabulations in its guidelines for diagnosing the 'Alcohol-Induced Amnesic Syndrome' (291.1). The aim of the present study, therefore, was to investigate whether confabulations may be considered a general feature of KS or whether their occurrence is negligible.

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The pathogenesis of KS is generally attributed to the direct neurotoxic effects of alcohol itself (Lishman, 1990; McIntosh & Chick, 2004) and a deficiency of thiamine (vitamin B1) due to the severe malnutrition of many alcoholics and their heightened threshold to metabolise thiamine (Martin, Singleton, & Hiller-Sturmhöfel, 2003; Thomson & Marshall, 2006). Additionally, a genetic vulnerability is also under discussion (Heap et al., 2002; Martin et al., 2003). Pathological brain alterations usually found in patients with KS concern diencephalic regions such as mammillary bodies, and the region enclosed by the anterior and mediodorsal thalamic nuclei, including the parataenial nucleus (Beracochea, 2005; Harding, Halliday, Caine, & Kril, 2000; Reed et al., 2003; Victor et al., 1989). Further neural degenerations concern the cerebellum, periaquaeductal and periventricular grey matter as well as the basal forebrain (Cullen, Halliday, Caine, & Kril, 1997; Kopelman, 1995; Victor et al., 1989). Atrophy of portions of the prefrontal cortex is also associated with the KS (Kopelman, 1995; Kril, Halliday, Svoboda, & Cartwright, 1997; Moselhy, Georgiou, & Kahn, 2001), and recently pathological alterations in hippocampal regions have been assumed to be related to KS as well (Caulo et al., 2005; Reed et al., 2003; Sullivan & Marsh, 2003). However, these findings are somewhat inconsistent, since some investigators could not corroborate hippocampal involvement in KS (Paller et al., 1997).

Besides the ambiguity whether confabulation is typical for KS or not, there is also considerable incongruity regarding a universally valid concept of confabulation. Operationally, confabulation can be defined 'as statements or actions that involve distortions of memory' (Metcalf, Langdon, & Coltheart, 2007). Confabulations mostly appear within the scope of organic memory disorders (Moscovitch, 1995; Schnider, 2003; Talland, 1965). For that reason, confabulations in amnesic patients used to be regarded as serving to fill memory gaps that are fabricated by amnesic patients in order to protect themselves from possible embarrassment (Berlyne, 1972; Bonhoeffer, 1904). However, since many patients with severe amnesia do not confabulate at all, today it is generally assumed that patients confabulate unconsciously that is without any intention to deceive (Dalla Barba, 1993a; Johnson, 1991; Moscovitch, 1995). In most reported cases of confabulating patients confabulations concern episodes from autobiographical ('episodic') memory (Dalla Barba, 1993a; Dalla Barba, Cappelletti, & Denes, 1990; Dalla Barba, Cappelletti, Signorini, & Denes, 1997), but there is also mention of patients producing confabulations regarding semantic facts (Dalla Barba, 1993b; Kopelman, Ng, & Van Den Brouke, 1997; Moscovitch & Melo, 1997). However, whether episodic and semantic confabulations can be regarded as one single entity or different entities is a controversial and unsolved issue until now. In addition to domain-specific variations, the content of confabulation may vary from subtle, plausible distortions (Dalla Barba, 1993a; Johnson, O'Connor, & Cantor, 1997) to bizarre, fantastic and wild narratives (Dalla Barba, 1993b; Damasio, Graff-Radford, Eslinger, Damasio, & Kassell, 1985; Metcalf et al., 2007). Some authors (e.g. Berlyne, 1972) have suggested that plausible confabulations would be elicited by direct questioning such as memory testing, whereas bizarre confabulations would occur rather spontaneously just by patient's everyday life, without any external triggers. However, the demarcation between bizarre and plausible confabulations is more often gradual than discrete. Moreover, spontaneous confabulators may produce non-bizarre confabulations (Dalla Barba, 1993a; Johnson et al., 1997). This is why the classification regarding the mode of elicitation, that is provoked versus spontaneous confabulation, has become more established than the distinction in bizarre/non-bizarre (Fischer, Alexander, D'Esposito, & Otto, 1995; Kopelman, 1987; Schnider, 2001). Nevertheless, in this matter, we find again some disagreement. For some authors all confabulations occurring out of a laboratory setting can be classified as spontaneous confabulation (Dalla Barba, Cappelletti, Signorini, et al., 1997; Kopelman, 1987). For others, acting upon the confabulation is an obligatory criterion for a spontaneous confabulation (Schnider, 2003). Furthermore, whether provoked versus spontaneous confabulations are distinctive entities with different neuroanatomical correlates or whether they represent a continuum of the same pathology is controversial as well (for review see Metcalf et al., 2007; Schnider, 2003). The heterogeneous behavioural patterns in confabulating patients make matters even more complex. Because of this diversity, some authors consider the dichotomy between spontaneous/provoked and bizarre/non-bizarre confabulation as quite arbitrary and suggest describing the idiosyncratic symptoms of individual confabulating patients rather than trying to categorize them (Metcalf et al., 2007).

In addition to KS, confabulations are associated with numerous other disorders such as ruptures of the anterior communicating artery (DeLuca & Diamond, 1995), traumatic brain injuries (Demery, Hanlon, & Bauer, 2001; Schnider, von Däniken, & Gutbrod, 1996b), and dementia (Dalla Barba, Nedjam, & Dubois, 1999; Tallberg & Almkvist, 2001). The neuroanatomical basis of confabulation is generally attributed to frontal lobe dysfunction, whereas the orbitofrontal (Schnider, 2001, 2003) and the medial prefrontal cortex (Gilboa & Moscovitch, 2002) seem to be those regions whose damage leads most regularly to confabulations. Evidence for a connection between prefrontal dysfunction and confabulations comes from neuropsychological studies reporting correlations between confabulations and executive dysfunctions (Kapur & Coughlan, 1980; Moscovitch & Melo, 1997), although there is also evidence against this assumption (Cooper, Shanks, & Venneri, 2006; Dalla Barba, 1993a; Schnider, Ptak, von Däniken, & Remonda, 2000). Moreover, lesions in frontal lobe regions do not inevitably lead to confabulations, since the majority of patients with frontal lobe lesions does not confabulate at all (see e.g. Dalla Barba, 1993b; Gilboa et al., 2006)—an observation that emphasizes the complexity of the neuroanatomical basis of confabulation.

Today at least two main theoretical approaches to explain confabulations can be distinguished (for a review see Metcalf et al., 2007). The first attributes confabulations to disturbances in temporal-context memory. According to Dalla Barba's theory of temporality (Dalla Barba, 2002) in confabulating patients a postulated temporal consciousness (an awareness for present, past and future) is malfunctioning in making temporal judgments of memories. Schnider (2001, 2003), on the other hand, argues that spontaneous confabulations are a result of a failure to inhibit memories that are considered to be irrelevant to the actual present, which consequently leads to a temporal confusion of ongoing reality with past events. The second theoretical approach encloses several retrieval theories of confabulation (Burgess & Shallice, 1996; Gilboa et al., 2006; Gilboa & Moscovitch, 2002). Such theories in general assume that frontal lobe-related functions organize and control retrieval from long-term memory. Due to frontal lobe lesions, one or multiple control processes (e.g. monitoring, focusing, and evaluation of memory retrieval) are disrupted and consequently distorted or completely false memories are retrieved. Broader theoretical frameworks are provided by Kopelman (1999) and Metcalf et al. (2007). In addition to general retrieval and evaluation deficits, these frameworks suggest personal beliefs or convictions to influence the specific content of an individual's confabulation (see also Fotopoulou, Conway, & Solms, 2007).

To summarise, various studies have already examined neuropsychological symptoms of the KS such as memory and executive functions (see e.g. Brokate et al., 2003; Fama, Marsh, & Sullivan, 2004; Oscar-Berman et al., 2004). However, there are no systematic analyses of confabulation tendencies in KS patients, even though confabulations are often mentioned as being a possible symptom

Table 1
Demographic variables of KS patients (KS) and comparison group (CG)

		KS, $N = 42$	CG, $N = 45$	Significance
Age	Mean (S.D.[a])	56.88 (7.31)	57.16 (9.40)	$t = 0.15$ ($p > .05$)
Gender	Male	31	32	$\chi^2 = 0.08$ ($p > .05$)
	Female	11	13	
Years of school education	≤12 years	39	38	$\chi^2 = 1.51$ ($p > .05$)
	>12 years	3	7	
Professional education	Unskilled	8	2	$\chi^2 = 5.87$ ($p > .05$)
	Apprenticeship	32	37	
	Academic	2	6	

[a] Standard deviation.

of the KS (Kopelman, 1995; Preuß & Soyka, 1997; Talland, 1965; Victor et al., 1989). Most studies either describe particular confabulating single cases with KS (Benson et al., 1996; Dalla Barba et al., 1990; Kopelman et al., 1997) or examine groups of confabulating patients with various etiologies (Kopelman, 1987; Moscovitch & Melo, 1997; Schnider, von Däniken, & Gutbrod, 1996a), but to our knowledge a systematic investigation of confabulations in larger patient samples with KS does not yet exist. To fill this gap, we examined a large sample of alcoholic KS patients regarding their confabulation tendencies. Since the value of spontaneous confabulations in everyday life is limited for experimental designs, we here applied a standardized neuropsychological test instrument. We chose the Confabulation Interview (Borsutzky, Fujiwara, & Markowitsch, 2006), the German Adaptation of the Confabulation Battery of Dalla Barba and colleagues (Dalla Barba, 1993a,b; Dalla Barba, Cappelletti, Signorini, et al., 1997). This instrument reliably assesses confabulation tendencies in separate memory domains such as personal semantic memory, episodic memory, general semantic memory, personal future and orientation. Thus, it can investigate whether confabulation tendencies in KS patients affect all memory domains equally or whether certain memory domains are more or less affected.

2. Methods

2.1. Participants

A total of 42 patients with alcoholic KS were recruited from four different socio-therapeutic nursing homes of the Allgemeine Hospitalgesellschaft (AHG) (Germany). All patients were permanent residents of the institutions and all had a clinical diagnosis of alcoholic KS. Alcoholic KS was formally diagnosed as ‘Alcohol-Induced Amnesic Syndrome’ according to ICD-10 (F 10.6: World-Health-Organization, 1994) or ‘Alcohol-Induced Persisting Amnestic Disorder’ following DSM-IV criteria (291.1: American Psychiatric Association, 1994), respectively. All patients underwent extensive neurological and psychiatric examination, conducted by physicians of the different cooperating institutions. All patients had a documented history or residual signs of a Wernicke episode, which preceded the chronic state of the KS, but according to our exclusion criteria none of the participating patients had signs of alcohol-related dementia according to the criteria of Oslin, Atkinson, Smith, and Hendrie (1998) or suffered from further significant neurological or psychiatric disease.

As a comparison group (CG), we recruited 45 healthy subjects without neurological or psychiatric history and without previous or current substance addiction. The CG was examined by students in the course of empirical tutorials. Accordingly, the control group consisted of relatives and friends of the students.

Before examination, all subjects gave their informed consent to participate in the study according to the Declaration of Helsinki (BMJ 1991; 302: 1194). Neither patients nor healthy subjects received financial incentives for their participation. All subjects were native German speakers and had grown up in Germany.

Groups were comparable regarding age, gender, years of school education and professional education (see Table 1).

2.2. Neuropsychological test battery

To examine the neuropsychological profile, we administered an extensive neuropsychological test battery to the KS patients: General cognitive state was screened by the German version (Kessler, Markowitsch, & Denzler, 1990) of the Mini-Mental-State-Examination (MMSE, Folstein, Folstein, & McHugh, 1975). To measure general verbal knowledge, we administered the subtest ‘Information’ of the German version (Tewes, 1991) of the Wechsler Adult Intelligence Scale-Revised (WAIS-R). Furthermore, premorbid intelligence was estimated with the German adaptation (Mehrfachwahl–Wortschatz–Intelligenztest (MWT) Lehrl, Merz, Burkhard, & Fischer, 1991) of the National Adult Reading Test (NART, Nelson, 1982). Regarding memory functions, verbal short-term memory was determined by ‘digit span forward’ from the German version (WMS-III-R, Härting et al., 2000) of the Wechsler Memory Scale-Revised, and by ‘Immediate Recall’ (first trial) of a verbal selective reminding task (Memo-Test, Schaaf, Kessler, Grond, & Fink, 1992). To study verbal working memory, we used the ‘digit span reversed’ (WMS-III-R, Härting et al., 2000). Verbal learning ability was evaluated by the mean recall of the words from the Memo-Test across five learning trials, and verbal long-term memory was measured with the 20-min delayed recall of the Memo-Test words (Schaaf et al., 1992). Visual long-term memory was assessed with 30-min delayed recall of the Rey–Osterrieth Complex Figure (Osterrieth, 1944). Speed of information processing was quantified by reading speed of the ‘Word Trial’ and the ‘Colour Trial’ of the Word Colour Interference Test of the Nürnberger-Alters-Inventar (NAI, Oswald & Fleischmann, 1997), developed on the basis of the Stroop-Test (Stroop, 1935). Considering executive functions, susceptibility to interference was assessed with the ‘Interference Trial’ of the Word Colour Interference Test (Oswald & Fleischmann, 1997), and verbal fluency was measured with the FAS-Test (Spreen & Strauss, 1998). Visual-spatial abilities were examined by the copy of the Rey–Osterrieth Complex Figure (Osterrieth, 1944).

Each test session lasted about 1.5–2 h; breaks were given on demand of the patients.

2.3. Confabulation Interview

To study confabulations in a standardized manner, we administered the Confabulation Interview (from the Testbatterie zur Erfassung von Konfabulationstendenzen (TEKT) Borsutzky et al., 2006), a German adaptation of the Confabulation Battery of Dalla Barba et al. (Dalla Barba, 1993a,b; Dalla Barba, Cappelletti, Signorini, et al., 1997) or the Modified Confabulation Battery (Dalla Barba et al., 1999), respectively. The Confabulation Interview is a semi-structured interview consisting of 55 questions probing different memory domains (see Table 2). In detail, the Confabulation Interview contains 10 questions on personal semantic memory, 10 on episodic/autobiographical memory, 10 on general semantic memory and 5 questions on personal future. Questions on personal semantic memory address general personal facts, such as name, date and place of birth. Questions on episodic memory address previously experienced autobiographical events. Questions on general

Table 2
Items of the Confabulation Interview: one example for each memory domain and the number of the corresponding items

Domain	Example-item	Number of questions
Personal semantic memory	What is/was your father’s job?	10
Episodic memory	Do you remember your last vacation?	10
General semantic memory	Who was Konrad Adenauer?	10
Personal future	What are you going to do next weekend?	5
Orientation	What day of the week is today?	10
Distractor episodic	Do you remember your Christmas present of 1990?	5
Distractor semantic	Why was the actrice ‘Marianne Wörner’ murdered by her husband in 1979?	5

semantic memory concern knowledge of German news events and famous people from several decades of the last century. Questions on personal future concern planned activities in the immediate future (see Dalla Barba, Cappelletti, Signorini, et al., 1997, 1999). Because confabulations may not only affect remote memory, but may also occur in subjectively experienced temporality of the personal present (Dalla Barba, Cappelletti, Signorini, et al., 1997; Schnider, 2000, 2001), 10 questions probing orientation in time and place from the Mini-Mental-State-Examination (Kessler et al., 1990) were included. According to the original Confabulation Battery of Dalla Barba and colleagues (Dalla Barba, 1993a,b; Dalla Barba, Cappelletti, Signorini, et al., 1997, 1999) distractor questions were constructed: 5 on general semantic memory and 5 on personal episodic memory. Distractor questions are questions which are logically coherent but have no reference to reality, so that the appropriate response to these questions would be 'I don't know'.

Answers were scored as 'correct', 'omission' or 'confabulation'. Answers to questions regarding personal semantic memory, episodic memory and personal future which have to be checked by proxy (25 questions in total) were verified by healthy subjects' relatives or by patients' medical staff, respectively. Since all KS patients were permanent residents of socio-therapeutic nursing homes and all of them lived at least several years in these institutions with tight socio-therapeutic attendance, personal carers were much more suited to verify patients' answers than their relatives (to whom, in most cases, patients had very little contact). KS patients' personal carer or healthy subjects' relative obtained a questionnaire with the answers of the study participants and had to rate them as 'true' (correct answer), 'false' (confabulation) or 'I cannot judge the correctness of this answer'. To keep the threshold for classifying answers as confabulations as high as possible, answers were scored as 'correct' whenever the proxy could not evaluate their correctness.

All correct answers and confabulations were summed up to constitute the 'Memory Score' or 'Confabulation Score'. In addition, correct answers and confabulations were scored and analysed separately for each domain.

For personal semantic memory, episodic memory, general semantic memory and orientation, we scored answers as 'omission' if the subject did not know the correct answer and responded with 'I don't know', 'I can't remember' or likewise (for personal future and distractor questions 'omissions' are not scored, see below). For personal semantic and episodic memory, we scored answers as 'correct' or 'confabulation', according to whether or not they were consistent with information obtained from healthy subjects' relatives or from patients' clinical staff. Answers to personal future were rated as probable or improbable with regard to the subject's immediate future: 'probable answers' were classified as 'correct' and 'improbable answers' were classified as 'confabulation'.

Since no definitive external criteria exist to distinguish a 'wrong answer' from a putative 'confabulation', and even apparently bizarre or fantastic confabulations may finally be traced back to real events (see Metcalf et al., 2007; Schnider, 2001), we tried to keep the methodological problem of differentiating a confabulation from a wrong answer as small as possible. Therefore, we decided to classify any wrong answer to general semantic memory and orientation (as well as to distractor questions) as confabulation. To minimize effects of unspecific response tendencies, such as utterances of wrong answers or confabulations, we provided our participants with rather strict test instructions: before the administration of the Confabulation Interview, we told subjects that the following test was going to measure remote memory performance and reassured them that no person is able to remember all aspects of his or her life. Therefore, nobody would score worse by not being able to answer a question. In addition, subjects were instructed insistently that they should only answer a question if they were completely convinced that their answers were right. Otherwise they should answer 'I don't know'. Whenever subjects gave wrong answers during testing they were asked once again whether they were absolutely certain about their answer. If they were uncertain, they were encouraged to retract their answer.

As mentioned above, for distractor questions only answers implying 'I don't know' or the like were accepted as 'correct'; any other response was scored as 'confabulation'.

3. Statistical analyses

All statistical analyses were carried out with the Statistical Package for the Social Sciences (SPSS) for Windows (Release 14.0.0, 2005; Chicago: SPSS Inc.).

Data were tested for normal distribution with the Kolmogorov–Smirnov test. In case of normally distributed data conventional parametric methods (*t*-test, Pearson correlations) were used. In case of significant deviation from the normal distribution corresponding non-parametric methods were applied (χ^2 test, Mann–Whitney *U*-test, Friedman test, Wilcoxon test, Spearman correlations). To make adjustments for multiple comparisons, results were Bonferroni-corrected when applicable.

Since the different domains of the Confabulations Interview comprise different numbers of questions (5 versus 10), all scores were converted into percentages.

4. Results

4.1. Neuropsychological test battery

Table 3 shows the results of KS patients in the neuropsychological test battery. For deriving a total score of performance, raw scores were *z*-transformed on the basis of normative data when available.

As can be seen from the mean score of the Mini-Mental-State-Examination, KS patients' general cognitive state was well-above the range of dementia ($M = 25.45$, S.D. = 2.63). Results in the MWT-B indicate a within-normal-range premorbid intelligence level ($M = 27.35$, S.D. = 5.21; IQ: $M = 103.85$, S.D. = 12.41). Results in the subtest 'Information' from the WAIS-R suggest a lower but nonetheless average level of general knowledge ($M = 13.33$, S.D. = 4.32). Hence, KS patients examined here, did not show a significant decrease in common intellectual abilities compared to normative populations.

In contrast to intact intellectual functions, the patients exhibited KS-specific severe anterograde memory deficits: in the Memo-Test they did not benefit from recurring presentations of the words across the five learning trials and thus did not show any relevant learning increase ($z = -2.26$, S.D. = 1.49). Additionally, patients showed very poor memory performance in the delayed recall of the Memo-Test ($z = -3.40$, S.D. = 1.53). Similar to their verbal long-term memory deficit, KS patients showed impaired figural long-term memory in delayed recall of the Rey–Osterrieth Complex Figure Test ($z = -1.69$, S.D. = 0.87). By contrast, short-term memory (first Trial of the Memo-Test and digit span forward) as well as working memory (digit span reversed) was in the average range (first trial of the Memo-Test: $M = 4.71$, S.D. = 1.10; digit span forward: $z = -0.72$, S.D. = 0.82; digit span reversed: $z = -0.83$, S.D. = 0.72). Despite intact performance in reading speed of the 'Colour Trail' ($z = -0.10$, S.D. = 0.92) of the Word Colour Interference Test, KS patients exhibited mildly increased reading time in the 'Interference Trial' ($z = -0.70$, S.D. = 1.04), suggesting a slightly enhanced susceptibility to interference. Similarly, performance in verbal fluency (FAS-Test) was intact, but in a lower average range ($z = -0.81$, S.D. = 1.06). In visuo-spatial abilities (copy of the Rey–Osterrieth Figure), KS patients exhibited no difficulties ($z = -0.50$, S.D. = 1.26).

4.2. Confabulation Interview

KS patients differed significantly from healthy controls (CG) in every domain of the Confabulation Interview, with the exception of semantic distractors (see Table 4). A multivariate analysis of covariance revealed only a main effect for 'group' (Memory Score: $F = 143.88$, $p < .001$; Confabulation Score: $F = 64.49$, $p < .001$) but no effects for 'gender', 'age', 'years of school education' or 'professional education', neither on the 'Memory Score' nor on the 'Confabulation Score' ($p > .50$). This indicates that our sample's performance in the Confabulation Interview seems to be independent of the socio-demographic variables mentioned above.

4.3. Memory performance

4.3.1. Between-group comparisons

Compared to healthy subjects, KS patients' total score of correct answers ('Memory Score') was significantly lower (KS: $M = 73.20\%$, S.D. = 7.82; CG: $M = 91.68\%$, S.D. = 4.41; $t = 13.45$, $p < .001$) as was their performance in each of the memory sub-domains (p's < .02, see Table 4). Numerically, the largest between-group difference

Table 3
KS patients' results in the Neuropsychological Test Battery

	Raw scores			Z-scores	
	Mean	S.D.[a]	Range	Mean	S.D.[a]
General cognitive state					
Mini-Mental-State-Examination	25.45	2.63	17–30	–[b]	–
Verbal intelligence					
MWT-B	27.35 (103.85[c])	5.21 (12.41[c])	6–34	0.28	0.81
General knowledge					
Information (WAIS-R)	13.33	4.32	5–21	–[b]	–
Memory					
Digit span forward	6.17	1.53	3–10	−0.72	0.82
Digit span reversed	5.05	1.34	3–8	−0.83	0.72
Memo-Test (immediate)	4.71	1.10	2–7	–[b]	–
Memo-Test (mean recall: trial 1–5)	5.37	1.06	3–7.4	−2.26	1.49
Memo-Test (delayed)	1.73	2.21	0–7	−3.40	1.53
Rey–Osterrieth Figure (delayed)	5.71	5.52	0–24	−1.69	0.87
Information processing					
Word Colour Test (Word Trail)	16.34[d]	3.34	12–26	–[b]	–
Word Colour Test (Colour Trail)	25.37[d]	7.34	19–58	−0.10	0.92
Executive functions					
Word Colour Test (Interference)	54.96[d]	21.13	30–154	−0.70	1.04
FAS-Test	30.00	11.20	10–61	−0.81	1.06
Visuo-constructive abilities					
Rey–Osterrieth Figure (copy)	29.78	4.97	17.5–36	−0.50	1.26

[a] Standard deviation.
[b] Normative data not available.
[c] IQ-scaled score.
[d] Time in seconds.

in memory performance was found in episodic memory and general semantic memory (episodic memory—KS: median = 60%, range = 10–100; CG: median = 100%, range = 80–100, $U = 105.00$, $p < .001$; general semantic memory—KS: $M = 39.29\%$, S.D. = 17.59; CG: $M = 76.89\%$, S.D. = 16.63, $t = 10.25$, $p < .001$). Conversely, we observed only a small difference in personal semantic memory (KS: median = 90%, range = 70–100; CG: median = 100%, range = 80–100, $U = 578.00$, $p < .001$). To further analyse general semantic mem-

Table 4
Results in the Confabulation Interview (declaration in percentile)

	Korsakoff patients (N = 42)		Controls (N = 45)		Significance	
	Median/mean[a] (%)	Range/S.D.[a]	Median/mean[a] (%)	Range/S.D.[a]		
Total scores						
Memory Score	73.20[a]	7.82[a]	91.68[a]	4.41[a]	$t = 13.45$	$p < .001$
Confabulation Score	14.55	3.64–30.91	3.64	0–12.73	$U = 112.00$	$p < .001$
Personal semantic memory						
Correct answers	90.00	70–100	100.00	80–100	$U = 578.00$	$p < .001$
Confabulations	0.00	0–20	0.00	0.00	$U = 585.00$	$p < .001$
Episodic memory						
Correct answers	60.00	10–100	100.00	80–100	$U = 105.00$	$p < .001$
Confabulations	30.00	0–70	0.00	0–10	$U = 116.50$	$p < .001$
General emantic memory						
Correct answers	39.29[a]	17.59[a]	76.89[a]	16.63[a]	$t = 10.25$	$p < .001$
Confabulations	10.00	0–60	0.00	0–40	$U = 505.50$	$p < .001$
Personal Future						
Correct answers	100.00	20–100	100.00	60–100	$U = 553.50$	$p < .001$
Confabulations	0.00	0–80	0.00	0–40	$U = 537.00$	$p < .001$
Orientation						
Correct answers	90.00	40–100	100.00	90–100	$U = 476.00$	$p < .001$
Confabulations	0.00	0–30	0.00	0–10	$U = 662.00$	$p < .001$
Distractor episodic						
Correct answers	80.00	20–100	100.00	20–100	$U = 691.00$	$p = .016$
Confabulations	20.00	0–80	0.00	0–80	$U = 639.50$	$p = .003$
Distractor semantic						
Correct answers	90.00	20–100	100.00	20–100	$U = 922.50$	$p = .84$
Confabulations	10.00	0–80	0.00	0–80	$U = 931.50$	$p = .90$

[a] In case of normal distributed data means and standard deviation are given.

ory, the 10 items were sub-divided into 5 questions about famous facts and people that became prominent until 1980 and 5 questions relating to the time after 1980. For both groups, statistical analysis (Wilcoxon test) revealed a temporal gradient: both groups had superior knowledge of facts and people from the decades until 1980 compared to the decades after 1980 (KS: $Z = -5.33$, $p < .001$; CG: $Z = -2.13$, $p = .033$). This gradient was much steeper in the KS group than in the controls (KS—items until 1980: median = 60%, range = 20–100; items after 1980: median = 20%, range = 0–80; CG—items until 1980: median = 80%, range = 40–100; items after 1980: median = 80%, range = 20–100).

In distractor items we found significant differences between groups regarding correct answers for episodic distractors ($U = 691.00$, $p = .016$), but not for semantic distractors ($U = 922.50$, $p = .84$).

4.3.2. Within group comparisons

Within the CG, we found ceiling effects of memory performance in all domains of the Confabulation Interview, with the exception of general semantic memory. Questions on general semantic memory were more difficult compared to questions aiming at the other memory domains, such as personal semantic memory ($Z = -5.15$, $p < .001$), episodic memory ($Z = -4.97$, $p < .001$), personal future ($Z = -5.15$, $p < .001$) or orientation ($Z = -5.41$, $p < .001$), as well as compared to episodic distractors ($Z = -3.27$, $p = .001$, all comparisons Bonferroni-corrected $p = .002$).

KS patients were significantly inferior in semantic and episodic memory compared to all other domains (p's < .001, Bonferroni-corrected $p = .002$). In addition, we found a significant difference between correct answers in episodic and general semantic memory ($Z = -4.60$, $p < .001$), with patients giving fewer correct answers in general semantic memory. With the exception of one significant difference between personal semantic memory and episodic distractors ($Z = -3.23$, $p = .001$), there were no differences in correct answers across the remaining domains (p's > .002).

4.4. Confabulations

4.4.1. Between-group comparisons

Compared to healthy persons, KS patients confabulated significantly more in every memory domain of the Confabulation Interview (p's < .001, see Table 4) and consequently showed a significantly higher total number of confabulations than controls (Confabulation Score—KS: median = 14.55%, range = 3.64–30.91; CG: median = 3.64%, range = 0–12.73, $U = 112.00$, $p < .001$).

Regarding distractor questions, we found between-groups differences in episodic distractors ($U = 639.50$, $p = .003$). In contrast, confabulations in semantic distractors did not differ between groups ($U = 931.50$, $p = .90$).

Analogous to the numeric results in memory performance, in confabulations again the groups differed most in episodic memory (KS: median = 30%, range = 0–70; CG: median = 0%, range = 0–10; $U = 116.50$, $p < .001$), whereas the smallest difference we found again in personal semantic memory (KS: median = 0%, range = 0–20; CG: median = 0%, range = 0, U = 585.00, $p < .001$).

4.4.2. Within-group comparisons

Although healthy subjects did not show considerable confabulations in any particular domain (all medians = 0), the number of confabulations on semantic distractors was nevertheless significantly higher compared to confabulations in personal semantic memory ($Z = -5.15$, $p < .001$), episodic memory ($Z = -4.08$, $p < .001$) and personal future ($Z = -3.90$, $p < .001$) as well as compared to orientation ($Z = -4.17$, $p < .001$) (all comparisons Bonferroni-corrected $p = .002$). Yet, comparing confabulations to semantic distractors with those to episodic distractors and general semantic memory questions did not reach significance (semantic distractors/general semantic memory: $Z = -2.81$, $p = .005$; semantic distractors/episodic distractors: $Z = -2.25$, $p = .025$). Thus, healthy subjects showed no substantial number of confabulations but if they confabulated, they most likely did so when probed with semantic distractors.

Patients confabulated most frequently to questions on episodic memory: comparisons to all other domains revealed significant differences (p's < .002, Bonferroni-corrected) with the exception of confabulations on episodic distractors (median = 20, range = 0–80) which failed to reach significance ($Z = -2.42$, $p = .015$) due to Bonferroni-correction. Personal semantic memory was least likely affected by confabulations (median = 0, range = 0–20) as indexed by significant differences compared to all other domains (p's < .002, Bonferroni-corrected). Thus, KS patients were least susceptible for confabulations in personal semantic memory. Furthermore, general semantic memory was slightly more affected by confabulations than orientation ($Z = -3.20$, $p = .001$). All other within-group comparisons of confabulations across domains revealed no differences (p's > .30).

We investigated confabulation tendencies in a large KS patient group in a quantitative manner and therefore did not analyse the contents of confabulation in detail. Nevertheless, an obvious question to follow up on would be to determine the bizarre or plausible nature of their confabulations qualitatively. Reviewing all questionnaires, we found no unequivocal instances of bizarre or fantastic confabulations in our patient group. In general, answers were plausible and semantically appropriate, so that for an unfamiliar observer the confabulation was not obvious. Most confabulations were temporal or contextual distortions of true experiences or events, or well-established routines of the patients' lives. For example, some patients lost track of their correct age (e.g. 60 years instead of 65 years) or gave false answers considering the length of their hospitalisation (e.g. hospitalisation since 1967 instead of 1993). With respect to episodic memory questions such as 'What have you done last weekend?', 'What have you done last New Year's Eve?', patients often gave answers which seemed to apply to the time before their hospitalisation, but were quite inadequate to their current situation (e.g. a patient with no contact to his family for several years claimed: 'I spent last New Year's Eve with my wife in a restaurant. . .', or '. . .last weekend my children popped up and we went swimming in the lake. . .'.) Similarly, we did not find bizarre or fantastic confabulations to episodic distractors. Again, patients gave reasonable answers in a somewhat stereotypical or probably wishful manner (e.g. to a question like 'Do you remember your Christmas present of 1990?' answers were 'a box of cigars', 'a bottle of whiskey' or 'a voltmeter'—an electrician's answer). Answers to semantic distractors in general contained a mixture of partly recalled actual public events and seemingly appropriate responses (a distractor question, for example, was: 'Why did the pharmaceutical company Espelkamp make the headlines?'; answers: 'because of some problems with the birth control pill', 'because of a chemistry accident in Leverkusen'. Another example: 'Why did the US-foreign minister have to leave office in 1983?'; answers: 'womanizing', 'love affair' or 'bribery').

4.5. Correlations between the Confabulation Interview and Neuropsychological Functions

The correlations of the Confabulation Interview and the results in the neuropsychological test battery are summarised in Table 5. The 'Memory Score' (total number of correct answers) of the Confabulation Interview was positively correlated with the general cognitive status (Mini-Mental-Status-Examination). Since the

Table 5
Correlations between the Confabulation Interview and Neuropsychological Tests

	Memory Score		Confabulation Score	
	r	*p*	*r*	*p*
General cognitive state				
Mini-Mental-State-Examination	.678	<.001	−.429	.005
Verbal intelligence				
MWT-B	.054	ns	.196	ns
General knowledge				
Information (WAIS-R)	.470	.003	−.100	ns
Memory				
Digit span forward	.153	ns	−.300	ns
Digit span reversed	.032	ns	−.163	ns
Memo-Test (immediate)	.323	.039	−.135	ns
Memo-Test (mean recall: trials 1–5)	.503	.001	−.400	.010
Memo-Test (delayed)	.397	.010	−.395	.011
Rey–Osterrieth Figure (delayed)	.379	.015	−.306	ns
Information processing				
Word Colour Test (Word Trail)	−.136	ns	.136	ns
Word Colour Test (Colour Trail)	−.236	ns	.077	ns
Executive functions				
Word Colour Test (Interference)	−.300	ns	.049	ns
Word Colour Test (Interference—colour)	−.255	ns	−.007	ns
FAS-Test	.327	.035	−.132	ns
Visuo-constructive abilities				
Rey–Osterrieth Figure (copy)	.368	.018	−.024	ns

domain ‘orientation’ of the Confabulation Interview contains questions of the Mini-Mental-Status-Examination (10 questions on orientation), partial correlations were computed, which still revealed a significant correlation between the ‘Memory Score’ and the score of the Mini-Mental-Status-Examination ($r = .340$, $p = .030$). Regarding intellectual functions, a correlation between the ‘Memory Score’ and the subtest ‘Information’ from the German version of the Wechsler Adult Intelligence Scale-Revised ($r = .470$, $p = .003$) was found. Partial correlations revealed that this relation was due to the high correlation between the domain ‘general semantic memory’ and ‘Information’ ($r = .637$, $p < .001$). Possibly both subtests measure general knowledge about the world in a similar manner. In addition, the ‘Memory Score’ was correlated with the memory performance in the Memo-Test as well as with the delayed recall of the Rey–Osterrieth Figure. Further correlations were found between the ‘Memory Score’ and verbal fluency (FAS-Test) and visuo-spatial abilities (copy of the Rey–Osterrieth Figure). However, both correlations were due to partial correlations: Whereas the relationship with verbal fluency was produced only by one domain, namely ‘general semantic memory’ ($r = .330$, $p = .033$), the relationship with the copy of the Rey–Osterrieth Figure was due to domains ‘general semantic memory’ ($r = .370$, $p = .017$) and ‘orientation’ ($r = .375$, $p = .016$).

The only significant relation between confabulations in the Confabulation Interview and other cognitive domains was found between the ‘Confabulation Score’ (total number of confabulations) and the Memo-Test (mean recall of learning trials 1–5 and delayed recall). Furthermore, the ‘Confabulation Score’ was negatively correlated with the score of the Mini-Mental-State-Examination, but partial correlations controlling for the domain ‘orientation’, obliterated the relationship ($r = -.266$, $p = .161$).

To summarise, our KS patients had preserved intellectual functions accompanied by severe anterograde memory deficits, a pattern typically observed in KS. In accordance with this, KS patients also showed inferior memory performance in the Confabulation Interview. While we discovered ceiling effects for all memory domains in the comparison group – with the exception of general semantic memory – the patient group performed worst in episodic and in general semantic memory. For confabulations in the comparison group complementary floor effects were found: healthy subjects did not show a large number of confabulations; if they confabulated, they were most susceptible to semantic distractors. In contrast, KS patients produced a remarkable amount of confabulations in the Confabulation Interview. They exhibited most confabulations in episodic memory. Furthermore, they showed a slightly enhanced confabulation tendency in response to episodic distractors. Patients’ memory performance in the Confabulation Interview was correlated with their general cognitive status, their performances in anterograde memory tests, their verbal fluency as well as their performance in visuo-constructive abilities. In contrast, the only relationship between confabulations and other cognitive functions was found in verbal memory: number of confabulations in the Confabulation Interview was negatively correlated with learning and delayed recall of a word list (Memo-Test).

5. Discussion

The results of our study suggest that confabulations can be regarded as a clinical feature of KS. Our patients produced significantly more confabulations in the Confabulation Interview than the comparison group of healthy subjects. Moreover, in contrast to other findings claiming that confabulations are a dominating symptom only of the acute phase of the WE and decrease during the chronic phase of KS (Benson et al., 1996; Hovarth, 1975; Kopelman, 1995), we found strong evidence that confabulations – at least provoked confabulations – are a persistent symptom of chronic KS.

Taking a look at the particular domains of the Confabulation Interview, KS patients exhibited most confabulations in episodic memory. Furthermore, they displayed a slightly enhanced confabulation tendency to episodic distractors. Compared to this, confabulation tendencies in other domains (personal semantic memory, general semantic memory, personal future, orientation and semantic distractors) were rather negligible and KS patients were least susceptible for confabulations to questions probing personal semantic memory.

Our result that KS patients confabulated most in episodic memory, is in accordance with other studies finding KS-patients to confabulate disproportionately more with reference to current and remote personal experiences (Benson et al., 1996; Dalla Barba et al., 1990; Fellgiebel, Scheurich, Siessmeier, Schmidt, & Bartenstein, 2003; Kopelman et al., 1997). Korsakoff himself noted that long-term alcoholics tend to generate fictitious anecdotes regarding their personal past (Korsakoff, 1889, 1891). In addition, studies examining confabulating patients with other aetiologies also often found confabulations to be prevailing in episodic memory, especially in patients with preserved general intellectual functions (Benson et al., 1996; Burgess & McNeil, 1999; Conway & Tacchi, 1996; Dalla Barba, 1993a,b; Dalla Barba, Boisse, Bartolomeo, & Bachoud-Levi, 1997; Dalla Barba, Cappelletti, Signorini, et al., 1997; Fotopoulou, Conway, Griffiths, Birchall, & Tyrer, 2007; Kato & Anamizu, 2001; Lee et al., 2007).

According to Dalla Barba's model of confabulation, domain-specific confabulations should be regarded as separate phenomena with different underlying pathologies (Dalla Barba, Cappelletti, Signorini, et al., 1997, 1999; Nedjam, Dalla Barba, & Pillon, 2000). Dalla Barba differentiates two different types of consciousness: a knowing consciousness and a temporal consciousness. Furthermore, he postulates a 'Long-Term Storage System', in which episodes, meanings or rules are stored without any additional temporo-spatial specification. In line with these assumptions, confabulations in episodic memory occur when the temporal consciousness about the personal present, past or future operates defectively in searching relevant memories from the 'Long-Term Storage System'. As a result, ordering of personal temporal context does not succeed and less stable modifications from long-term memory cannot be used, but instead only more stable ones. Therefore, when patients have to answer to questions probing episodic/autobiographical memory, they might employ well-established routines or habits, even if these are inadequate to current circumstances. Conversely, semantic confabulations will occur when awareness about general knowledge (knowing consciousness) is malfunctioning. In this case the more stable modification of the 'Long-Term Storage System' cannot be triggered and patients may also produce confabulations concerning semantic facts.

In our patients, we found disproportional confabulations in episodic memory, while the other memory domains were much less affected. This finding is in accordance with the model of Dalla Barba postulating domain-specific confabulation with different underlying mechanisms. One may expect patients with a more pronounced cognitive decline than patients examined here (e.g. patients with dementia) to exhibit confabulations beyond episodic memory. This assumption is supported by some studies finding a relationship between cognitive status and semantic confabulations in patients with Alzheimer's disease (Lee et al., 2007; Tallberg & Almkvist, 2001).

Using the Confabulation Battery, Dalla Barba et al. (Dalla Barba, Boisse, Bartolomeo, & Bachoud-Levi, 1997; Dalla Barba, Cappelletti, Signorini, et al., 1997, 1999) often found a high number of episodic confabulations accompanied by fewer confabulations in orientation and/or personal future. We did not replicate this pattern of confabulation. Beside the obvious preponderance of confabulations in episodic memory, KS patients had a slightly enhanced confabulation tendency in each domain of the Confabulation Interview compared to healthy individuals but they show no further notable peak of confabulation in any of the remaining domains.

This divergence in findings may be due to different aetiologies or different lesion sites in previous patients and our sample. The majority of cases examined by Dalla Barba and colleagues showing high episodic/low orientation and future-related confabulations were dementia patients (Dalla Barba et al., 1999) or patients with aetiologies other than KS (Dalla Barba, Boisse, Bartolomeo, & Bachoud-Levi, 1997; Dalla Barba, Cappelletti, Signorini, et al., 1997). In contrast, in the single case with KS described by Dalla Barba and colleagues (Dalla Barba et al., 1990) confabulations were found to be restricted to episodic memory—a result similar to our finding. Since Dalla Barba et al. at that time did not include questions referring to orientation, personal future and personal semantic memory, one may speculate that their patient may also have exhibited some confabulations in other memory domains. Possibly due to our larger sample, we found a greater variation in confabulations across memory domains. This result may reflect a general disposition in KS to produce false memories or confabulations, whereupon this dysfunction may culminate in the most vulnerable memory domain—that is episodic memory.

As suggested in previous studies (e.g. Turner, Cipolotti, Yousry, & Shallice, 2008), different types of confabulations may result from different lesion locations (see below). Unfortunately, brain imaging data from patients were not consistently available. Due to the probable variation in brain pathology, our group may have contained different types of confabulators whose confabulations may manifest across a broader range of memory domains. Thus, it is also possible that our KS patients' broader range of confabulations was due to heterogeneity in affected brain regions.

Our study focused on the quantitative analysis of confabulation in a patient group, and therefore we did not systematically analyse the contents of confabulations. However strikingly, on qualitative inspection, the confabulations produced by our patients were never bizarre or fantastic. In contrast, KS patients produced plausible confabulations, quite adequate in content and form, and without external validation, their confabulations would not have been obvious. Considering the confabulations in episodic memory, confabulations seemed to refer to fragments of recollections of patients' previous lives. Thus, in accordance with Dalla Barba's model, patients seem to be unable to retrieve proper information from long-term memory and instead replied with over-learned memories, idiosyncratic routines or habits.

Compared to all other domains of the Confabulation Interview, KS patients showed the lowest memory performance in episodic and general semantic memory. Reduced general semantic memory was unlikely due to deficits in general knowledge, since patients scored normally in other tests measuring intellectual functions. Instead, this may reflect remote memory deficits similar to episodic amnesia typically found in KS. General semantic memory questions in the Confabulations Interview concern famous German events and famous people from several decades of the last century—before 1980 and thereafter. Since our patients suffer from long-lasting alcohol addiction (duration: 10–46 years), disturbances in storage of new facts – after 1980 – may be the main reason for the low performance in general semantic memory. This assumption is confirmed by the patients' distinctively steeper temporal gradient (before 1980 versus after 1980) in general semantic memory compared to the control group.

The results of KS patients displayed in the neuropsychological test battery administered here were in accordance with the usually described neuropsychological profile found in KS (for review see Brand, 2007): KS patients showed relatively intact intellectual functions but exhibited severe anterograde memory deficits concerning verbal memory as well as visual memory.

In our patient group we found only one noteworthy relationship between confabulations and other cognitive functions: total number of confabulations was negatively related with anterograde memory performance. Consistent with previous studies (Fischer et al., 1995; Tallberg & Almkvist, 2001; Turner et al., 2008), our finding suggests memory disturbances are at least a necessary condition for confabulations. On the other hand, our results do not provide evidence that a desire for filling memory gaps is a motivator to confabulate. If the intention to fill gaps of memory was the main cause of confabulating, one should expect the biggest number of confabulations in those memory domains where patients performed worst. This, however, was not the case. KS patients exhibited lowest scores in general semantic memory but compared to the other domains, they did not show notably increased susceptibility for confabulation here. In addition, the confabulation tendency to distractor questions, i.e., questions that cannot be answered and therefore produce an artificial memory gap, was not strikingly increased compared to other domains.

In contrast to some other studies (Kapur & Coughlan, 1980; Kopelman et al., 1997; Moscovitch & Melo, 1997) we did not find a relationship between confabulation and executive sub-components examined here. Previous findings about the association between confabulation and executive functions are somewhat heterogeneous. While some authors postulate executive functions as being a necessary precursor, or even a sufficient condition to confabulation (Benson et al., 1996; Burgess & McNeil, 1999; Fischer et al., 1995; Gilboa & Moscovitch, 2002; Kopelman et al., 1997), others do not find such correlation (Dalla Barba et al., 1999; Nedjam, Devouche, & Dalla Barba, 2004). It should be noted that we only employed two tests measuring a few subsets of executive functions, namely verbal fluency and susceptibility to interference. Therefore, we cannot ultimately conclude that other aspects of executive functions are not related to confabulation. Neuroanatomical studies which suggest frontal lobe degeneration as part of the KS pathology (Kril et al., 1997; Moselhy et al., 2001; Reed et al., 2003) imply that executive functions may be impaired in KS patients. Therefore, one may expect that other aspects of executive functions than examined here, may have a relationship to confabulation depending on the specific pattern of brain damage and given the employment of finer-grained assessments of executive functions.

From a critical point of view two limitations of our study should be mentioned here: first, we only investigated provoked confabulations, and therefore cannot infer that the patients examined here will show spontaneous confabulations in daily life. Admittedly, the qualitative description of spontaneous confabulations is suitable for studying single cases, generating heuristics about the nature of confabulations and their neuroanatomical basis. However, for clinical purposes, the application of a standardized test instrument is preferable. Even if single remarkable or bizarre utterances by spontaneous confabulators cannot be taken into consideration, by using a standardized test instrument, the magnitude of confabulation tendencies in a population of patients can be measured in a reliable and consistent manner. This, again, allows comparing confabulation tendencies within a patient group and between different patient groups. The next step of investigation then may be combining test results with supplementary data—e.g. collecting spontaneous confabulations or neuroanatomical data for further exploration of the interrelation between behaviour and neuroanatomy.

A second critical remark may address the possibility that questions posed in the Confabulation Interview differ regarding their retrieval demands. One may argue that questions probing episodic memory in the majority of cases have a temporal component. To answer such questions requires an effortful strategic memory retrieval (Cooper et al., 2006; Moscovitch & Melo, 1997). In contrast, questions probing general semantic memory usually do not have such a temporal component and therefore can be answered briefly with a single word or phrase—so that answering them involves only automatic cue-dependent processes. Following this line of reasoning the preponderance of confabulations in episodic/autobiographical memory found here could be due to different demands on retrieval processes and therefore would only be a methodological artefact. However, several studies in which confabulations were induced with the Confabulation Battery of Dalla Barba et al. as well as with techniques equating retrieval demands for semantic and episodic memory (modified version of the Crovitz test) could confirm domain-specific confabulation (Dalla Barba, Cappelletti, Signorini, et al., 1997, 1999). Moreover in a novel neuroanatomical study, Turner et al. (2008) found strong evidence that domain-specific confabulations have different neural correlates. They administered the Confabulation Battery to an unselected patient group with frontal lobe lesions and found that damage to orbital, medial and left lateral prefrontal lobes was associated with confabulations to episodic memory questions, whereas damage to orbital, medial and right lateral prefrontal lobes led to confabulations in orientation questions. Finally, if the predominance of confabulations in episodic memory was only due to greater retrieval demands, one would have expected this to apply to healthy individuals, too. However, our comparison subjects – even if they produced only marginal confabulations in the Confabulation Interview – confabulated most in response to semantic distracters. This, obviously, is in stark contrast to the confabulation profile of KS patients. In summary, our results and previous studies permit the assumption that confabulation may occur domain-specific and that in amnesic patients the episodic memory system seems to be most vulnerable to confabulations.

To conclude, our study provides evidence that confabulation in KS patients is a characteristic clinical symptom that is present even after years of disease onset. Thus, within the neuropsychological examination, the screening of confabulatory tendencies may provide supplementary information about the cognitive profile of KS patients.

In addition, our results suggest that confabulations of KS patients do not affect all memory domains to the same degree, but mostly affect autobiographical aspects of episodic memory. This finding matches well with Korsakoff's early descriptions as well as previous anecdotic reports stating that KS patients confabulate spontaneously in everyday life mainly with respect to their personal past and present. Moreover, the preponderance of confabulation in episodic memory, observed in our study, rather favours interpretations of domain-specific confabulations than a general retrieval deficit. Establishing the nature and extent of confabulations in a large sample of KS patients here, future studies may identify the specific neural and behavioural mechanisms determining domain-specific confabulation in KS patients. A recent study (Turner et al., 2008) suggests that different patterns of brain lesions may underlie domain-specific confabulations.

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