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Research Article

Low effective organizational strategies in visual memory performance of unmedicated alcoholics during early abstinence

Weniger effektive Organisationsstrategien in visueller Gedächtnisleistung bei unmedizierten Alkoholikern in der frühen Abstinenzphase

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Abstract

Objective: Alcohol-dependent patients in early abstinence show an impairment of cognitive functions which can be seen in poor implementation of newly learned skills for avoiding relapse. Executive dysfunction may persist during abstinence in alcohol-dependent persons, thus mitigating long-term abstinence. This study assessed visual memory function and choice of organizational strategies in alcoholics, as these are major factors necessary to implement ongoing behavior changes which are required for maintaining abstinence.
Methods: We investigated 25 severely alcohol-dependent male patients between days 7 to 10 of abstinence, immediately after clinical withdrawal symptoms have ceased, compared to 15 healthy age, sex, and education matched controls. Pharmacological therapy had been terminated at least four half-lifes before inclusion into the study. Visual perceptual learning and organizational strategies were assessed with the Rey-Osterrieth Complex Figure Test (R-OCF).
Results: There were no group differences in copying or recalling the figure, but time differences occurred. Alcoholics and healthy controls performed worse in recalling than in copying. But, alcoholics used less effective organizational strategies.
Conclusions: There was a deficit in choice of organizational strategy in newly abstinent and unmedicated alcohol-dependent patients. Due to the imperfect organizational strategies, alcoholics might need auxiliary therapeutic care to strengthen their cognitive ability.

Keywords: alcoholism, withdrawal, executive functions, visual memory, organizational strategy

Zusammenfassung

Hintergrund: Alkoholabhängige Patienten in der frühen Abstinenzphase zeigen Einbußen in ihren kognitiven Funktionen, welche in der geringen Anwendung neu erlernter Fertigkeiten deutlich werden, um einen Rückfall zu verhindern. Exekutive Dysfunktionen können bei Alkoholikern in dieser Phase der Abstinenz überdauern und somit eine Langzeit-Abstinenz beeinträchtigen. Die vorliegende Studie erfasst visuelle Gedächtnisfunktionen und die Wahl der Organisationsstrategie bei Alkoholikern. Diese Faktoren sind bei der Anwendung neu erlernter Verhaltensweisen notwendig, um die erlangte Abstinenz aufrecht zu erhalten.
Methoden: Wir verglichen 25 alkoholabhängige männliche Patienten zwischen dem 7. und 10. Tag der Abstinenz, direkt nachdem die klinischen Entzugssymptome aufhörten, mit einer gesunden für Alter, Geschlecht und Bildung abgeglichenen Kontrollgruppe (n=15). Eine Pharmakotherapie wurde mindestens vier Halbwertszeiten vor Einschluss in die Studie beendet. Visuelles Wahrnehmungslernen und Or-

ganisationsstrategien wurden mit dem Rey-Osterrieth Complex Figure Test (R-OCF) erhoben.

Ergebnisse: Es wurden keine Gruppenunterschiede in der visuellen Gedächtnisleistung und der Wahl der Organisationsstruktur bei abstinenten, unmedizierten alkoholabhängigen Patienten im Vergleich zu gesunden Kontrollpersonen gefunden. Beide Gruppen erreichten weniger gute Werte in der Reproduktions-Aufgabe als in der Kopier-Aufgabe. Jedoch zeigten abstinente Alkoholiker weniger effektive Organisationsstrategien als gesunde Kontrollpersonen.

Schlussfolgerung: Es bestand ein Defizit in der Wahl der Organisationsstrategie bei abstinenten, unmedizierten Alkoholikern. Aufgrund der weniger effektiven Organisationsstrategien könnten Alkoholiker von einem zusätzlichen therapeutischen Angebot profitieren, um ihre kognitiven Fertigkeiten zu stärken.

Schlüsselwörter: Alkoholismus, Entzug, exekutive Funktionen, visuelles Gedächtnis, Organisationsstrategien

Introduction

Chronic alcohol consumption leads to cognitive impairment, which may manifest at early stages of alcohol abstinence, and which is associated with deficits of specific memory functions [1], [2], [3], [4], [5]. Indeed, about 45% of alcohol-dependent individuals show deficits in cognitive functions persisting several weeks of abstinence, which may be due to residual effects of alcoholism. Fifteen percent of these patients show an impaired memory one year after having ceased to consume ethanol [6]. Neuropsychological studies on recently detoxified alcoholics have consistently attested the presence of cognitive deficits, particularly in the domains of sustained attention, executive functions, nonverbal memory, and visuo-spatial functions such as visual working memory [7], [8], [9], [10], [11], [12], [13], [14]. However, initial findings of low perceptual clustering (an index that attempts to quantify the degree to which a person uses an organized strategy in their approach to the Rey-Osterrieth Complex Figure Test (R-OCF)), low constructional accuracy, and the use of inefficient problem-solving strategies generally seem to improve in alcoholics with long-term abstinence, i.e., at least 18 months of abstinence. This association suggests that present alcoholism is a factor in the development of these cognitive deficits [15].

Studies investigating visuo-spatial processing in alcoholics as a function of duration of abstinence have given disparate results. Impairments in visual memory function was measured with the Wechsler Memory Scale in recently detoxified (one month), intermediate-term abstinent (two years), and long-term abstinent (seven years) alcoholics; there was improved memory performance with increased duration of sobriety [13], [16]. Further, visual memory function was investigated with the Delayed Vernier Discrimination Task as a function of duration of abstinence. Here, the alcoholic group did not exhibit significant impairment of the task compared to healthy control subjects within the first three weeks after cessation of alcohol consumption [17]. In yet another study, visual perception and perceptual learning performance was measured in recently detoxified alcoholics using the Gollin Incomplete Pictures Test, the Hidden Figures Test and the Wechsler Memory Scale; results showed that alcoholics performed worse than healthy controls [18]. The authors speculated that, whereas healthy controls need only to invoke basic visuo-spatial processes for perceptual learning, alcoholics had to invoke higher-order cognitive processes in order to perform at a normal level. Finally, among the different tasks that can be used to investigate visual memory function, figure reproduction tasks can measure visual short-term memory [13]. The individual's performance in such tasks also depends on organizational strategies, as these tasks engage executive function-based components of visual memory function [17]. Executive functions are conceptualized as a rather elusive set of processes enabling abstract thinking such as planning, decision-making, coordinating, sequencing, and monitoring of cognitive operations [19], all of which have been linked to the frontal lobe.

The Rey-Osterrieth Complex Figure Test (R-OCF) is a widely-used instrument for assessing visual memory, which gives scores for both figure reproduction performance and organizational strategies, i.e., the particular skills serving as a basis for optimizing figure reproduction [20], [21]. In accordance with other test results, alcoholics displayed visuo-spatial impairments in R-OCF performance, even with correction for group differences in premorbid IQ and education [22], [23]. Alcoholics who were three weeks abstinent performed significantly less well than controls in drawing as accurately as possible the figure which they had just observed [9]. But no significant differences were found between eleven week abstinent alcoholics and controls. Some recovery of visuo-spatial functioning may occur in alcoholics after ten weeks of abstinence [9].

Replications of this latter finding have been interpreted as evidence for visuo-spatial recovery (e.g. [24]). However, it has to be taken into account that decreased visuo-spatial function may be due to poor choice of organizational strategy, rather than memory loss per se. The R-OCF allows classification and evaluation of the efficacy of the individuals' organizational strategy approach. A holistic approach to copy a complex figure needs a higher organizational strategy rather than a piecemeal approach, and can achieve better accuracy scores in copy after delay [20], [21]. Disturbances of higher-order cognitive function have been described in patients with diagnosed alcoholism [24], [18]. For example, alcoholics who were detoxified for about one month showed lower accuracy and strategy scores in a copy and recall task compared to healthy controls. Furthermore, copy strategy independently affected copy and recall accuracy scores. As a consequence, the recall deficit in alcoholics could be attributed to abnormalities in both accuracy and strategy [25], which may in part resolve with prolonged sobriety [15].

But to date, no study has investigated visual accuracy and organizational strategy just after resolution of clinical withdrawal symptoms, at a very early stage of cessation of psychotropic medication. This time point is very critical because, once patients stop showing objective withdrawal symptoms, their access to high intensity treatment facilities is limited. However, patients with subtle disturbance of cognitive functions may benefit from on-going treatment at this critical time point most likely due to increasing efficiency of neural pathways over time [9], [26], [27].

To test this claim, we used the R-OCF to measure reproduction accuracy, organizational strategy, and their interdependence in visual memory functioning in alcoholics at seven to ten days after onset of detoxification. The study was designed that only patients free of clinical withdrawal symptoms and psychotropic medication were included. Based on the results of previous studies, we hypothesize that (1) since copying a figure is a less complex task than recalling a figure, the alcoholic and matched control group will both achieve higher copy than recall scores, (2) the group of alcohol-dependent patients will show lower performance in visual memory, especially in recall, than do healthy controls, and (3) alcohol dependent patients use less effective organizational strategies in copying as well as in recalling the figure.

Method

Study population

The study was approved by the local ethics committee. Written informed consent was obtained from all participants after the procedures had been fully explained. None of the study participants had an uncorrected visual disorder, and all were able to understand the instructions given by the investigator. Visual disorder was excluded by binocular reading of short German language texts in font size 11 from a distance of 50cm, eye movement tests (horizontal, vertical, fixation during movement), and subjective information of presence or absence of double images. All patients underwent complete neurological and physical examination as part of their routine workup at the clinic. Patients were recruited at the psychiatric ward of the Charité – University Medical Center at the St. Hedwig Hospital and the Jewish Hospital in Berlin, Germany. Twenty-five male alcoholic patients aged 45 years (*SD*=8.41) were included. Diagnosis of alcohol dependence was based on the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I) [28]. All patients fulfilled DSM-IV criteria for alcohol dependence. Upon admission, alcohol abstinence was enforced for between seven and ten days before testing, i.e., until conclusion of overt withdrawal symptoms. None of the patients consumed substances other than tobacco or suffered from active medical or neurological disorders. During detoxification, withdrawal symptoms were monitored according to the alcohol withdrawal scale (AWS) [29]. Medication to treat withdrawal symptoms was given in all cases with a score of ten or higher. In cases with a positive history of seizures (n=11) or delirium (n=8), medication was administered with scores of eight to ten. Of these eleven patients, five patients reported having had both delirium and seizures, and six patients reported having had seizures but no delirium. There were no instances of seizure or delirium during the inpatient stay. Medications for withdrawal included diazepam, clomethiazole, oxcarbazepine or clonidine. During the acute withdrawal before inclusion into the study all patients with a history of delirium or seizures needed to be medicated for a mean of five days (*SD*=4). Also eight further patients with AWS score exceeding ten were medicated for a mean of five days (*SD*=4). However, the days before entering the study all patients were free of clinical withdrawal symptoms, and did not receive psychotropic medication other than as specified above. Medication was discontinued for a minimum of four half-lifes before psychometric testing (half-lifes of diazepam metabolites were included). After discontinuation clinical withdrawal symptoms did not reappear. Of the 22 patients who received medication 15 were solely treated with clomethiazole, two solely with diazepam and five with a combination therapy of oxcarbacepine and clonidine.

Patients reported their first alcohol consumption at the average age of 14.4 years (*SD*=3.6, range = 27 to 56 years), and were diagnosed with alcohol dependence for an average of 19.2 years (*SD*=10.2). Nineteen patients reported prior detoxifications, with an average of 10.8 (*SD*=10.8) instances of prior detoxification. The mean amount of pure ethanol intake per patient during the previous five years was 245kg (*SD*=177), which corresponds to a mean of 13.40 standard 10 gram ethanol drinks per day. The IQ-Score ranged between 55 and 114 (*M*=86.03, *SD*=14.29). Years of education ranged between eight and twelve years, with an average of ten years of education.

The comparison group comprised 15 healthy controls matched for age (*M*=44.2 years, *SD*=11.1, range = 25 to 63 years), sex, and education (*M*=10.4 years, *SD*=1.5, range = 8 to 12 years with an average of ten years of education). The IQ-Score ranged between 79 and 127 (*M*=103.14, *SD*=14.02). None of the healthy controls fulfilled diagnoses according to DSM-IV (SCID-I), or reported neurological or other medical diseases in their past medical history. None of the control subjects received medications, or had any history of alcohol abuse or alcohol dependence according to DSM-IV.

Assessment of visuo-spatial constructional ability and visual memory

The purpose of the R-OCF is to assess visuo-spatial constructional ability and visual memory. This test assesses a variety of cognitive processes, including planning, organizational skills, and problem-solving strategies, as well as perceptual, motor, and memory functions [30]. We chose the R-OCF because it probes the domain of declarative memory, as well as the individuals' visuo-constructional performance (strategy to copy a figure) and memory performance (recalling the figure and recognition of details) [30], [31] (Figure 1). The tests were performed in strict accordance with the suggested procedure in the R-OCF handbook [32]. The R-OCF is an incidental rather than an intentional memory test [33], to the effect that the subjects are not informed that they will have to draw a figure from memory when asked to draw it initially on copy condition.

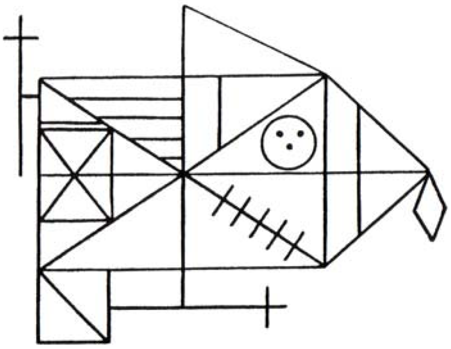

Figure 1: The original picture of the R-OCF (Osterrieth, 1944 [20]; Knight and Kaplan, 2003 [32])

Procedure

In the first step, the individual was asked to simply copy a figure onto a blank sheet of paper, while the examiner closely observed the individual, and recorded a score for the qualitative variable *"approach to task"* (whole-to-part vs. part-to-whole strategy). In the second step, three minutes after completion of the first copy, and without prior instructions, the subject was asked to reproduce the figure as correctly as possible from memory on a blank sheet of paper (*immediate free recall with three-minute delay*). Thirty minutes after the immediate free recall was completed, in the third and final step, the subjects were asked to reproduce the figure once again from memory as correctly as possible, and without prior instructions (*delayed recall*). During the intervening time span between immediate free recall and delayed recall, the participants were occupied with identical additional testing, comprising a verbal learning and memory test, and a conditioning paradigm. The individual's net time spent for accomplishing the test ranged between 10 and 15 minutes, excluding the delay interval. The criteria for scoring accuracy of copy and recall, as well as the individual's drawing strategy, are provided in the handbook [32]. Before study onset, the raters had participated in a rater training for the scoring according to the handbook. But, the raters were not blinded in terms of diagnoses.

Accuracy

According to the handbook, the figure is partitioned into 18 scoreable elements. For each reproduced element zero, one or two points are awarded on the basis of accuracy, distortion, and location. Two points are given if a unit is correct and placed properly, one point is given if the unit is correct but placed poorly; one point is given if the unit is distorted but placed correctly; half a point is given if the unit is distorted and placed poorly, and no point is given if the unit is absent or not recognizable. The highest possible score for each figure is thus 36. Normative data is available for participants between 18–89 years for copy, three-minute, and 30-minute recall [30], [32].

Strategy

The test also provides a score of the subject's strategy for copying and reproducing the figure. The strategy score assesses the constructional organization of the framework as the core of the drawing. For this purpose, the examiner carefully observed the process of drawing, and recorded the approach-to-task (whole-to-part vs. part-to-whole strategy). With respect to Sullivan et al. [25], the strategy scoring system is based primarily on organization of the drawing, as elaborated in the handbook [32] (Table 1).

Statistical Analysis

Data were analyzed using SPSS Version 15.0 for Windows. Data were screened for multivariate outliers by means of residual plots, and a $p<.001$ criterion for Mahalonobis distance, as provided by SPSS regression. Particular attention was given to multivariate extreme responses because they can result in severe distortion of findings based upon the present analyses [34]. One multivariate outlier identified in the alcoholic group was excluded from subsequent analysis. The IQ of the outlier which was excluded was 84.

Data of the R-OCF test were analyzed using a repeated measures analysis of variance (ANOVA), with "accuracy score" as the repeated-measures factor and "group" (patients-controls) as the between-subjects factor. Total group size of 42 was reduced to 40 after exclusion of one case with a missing value, and the multivariate outlier noted above. The first step in the repeated measures analysis of variance was to calculate the Mauchly test for sphericity. To correct for violations of sphericity, we used the Huynh-Feldt correction, which alters the degrees of freedom, thereby altering the significance value of the *F*-ratio. Furthermore, univariate post hoc tests were con-

Table 1: Seven-category typology for classifying R-OCF

Type I	Starting with the centre rectangle, which then serves as the foundation for all the remaining elements of the drawing.
Type II	Drawing begins with one of the exterior details attached to the central rectangle, then the rectangle is completed and other details added.
Type III	General shape or outline of the complex figure is drawn first, then the internal details are added. The central rectangle and main structures are not the basis for positioning the detail elements.
Type IV	Juxtaposition of details, one following another, without drawing any base rectangle, resulting in a generally recognizable whole figure. This method of progressing from one detail to the next in sequence can result in a completed figure that resembles the model, but without the recognition of, or organization around, the main structural components.
Type V	Recognizable details are present in the context of a confused background of lines (no strategy is evident for organizing the details into a coherent figure).
Type VI	Reduction of the figure to a familiar scheme.
Type VII	An unrecognizable scrawl.

ducted with Bonferroni correction, so as to protect against Type I errors arising when multiple comparisons were made. The effect-size for the analysis of variance is partial eta squared (partial η^2). To test the distribution of the organizational strategy, we used the two-sample Kolmogorov-Smirnov Test (KS-Test), which is a non parametric test of whether two samples arise from the same distribution. The two-sample KS test is sensitive to differences in both location and shape of the empirical cumulative distribution functions of the two samples.

Furthermore, the relationship between alcohol consumption and accuracy was calculated with Pearson's correlation. The relationship between alcohol consumption and strategy was calculated with Spearman Rho, which is a non-parametric version of the Pearson correlation coefficient, based on the ranks of the data rather than on actual values. Correlation values of r>.10 were considered to be a small, r>.30 a medium, and r>.50 as a large effect size [35].

Results

Group differences in copying and recalling regarding accuracy

A repeated-measure analysis of variance was performed with the dependent variable accuracy, i.e. copy accuracy, recall accuracy at three minutes delay, and recall accuracy at 30 minutes delay. The independent variable was group. The analysis was controlled for age, education, and IQ which were included as covariates.

In copy accuracy, alcoholics obtained a mean score of 34.77 (range 24 to 36) comparable to healthy controls who reached a mean score of 35.73 (range 32 to 36). In immediate recall, alcoholics had a mean score of 19.98 (range 8 to 30) whereas healthy controls had a mean score of 25.17 (range 18 to 29). For 30-min delayed recall, alcoholics had a mean score of 19.75 (range 11 to 30), whereas healthy controls had a mean score of 24.62 (range 18 to 29). All details are shown in Table 2.

Because of a significant Mauchly test for sphericity (W=0.42, approximate chi-square = 28.38, df=2, p<.001), we used the Huynh-Feldt test to test for group differences. Results showed a significant main effect for the different test sessions, i.e. copy accuracy was better than recall accuracy (F (1,45)=4.89, p=.02, partial η^2=.12).

Univariate post hoc tests with Bonferroni correction were calculated for each measurement point. Setting a family-wise type-I error corrected significance level at p<.02, univariate tests indicated significant differences for the second and third measurement points. Results reflected no group difference for the first measurement point; i.e. alcohol dependent patients did not differ from healthy controls while copying the figure. However, there was a significant difference at the second measurement point (recall after three minutes delay; F (1,41)=6.89, p<.01, partial η^2=.16), as well as for the third measurement point (recall after 30 minutes delay; F (1,41)=7.70, p<.01, partial η^2=.17). Alcohol dependent patients reproduced the figure at both measurement points with fewer details. No effects appeared for age and education. Figure 2 shows the results of the visual memory test for alcohol-dependent patients compared to healthy controls.

No interaction appeared, i.e., alcoholics did not differ from healthy controls in their accuracy scores regarding copy and recall if age, education and IQ were taken into account. If the groups were matched for IQ in an extra subsample to eliminate the influence of the IQ (alcoholics n=7, healthy controls n=7), same results appeared, i.e. results showed a significant main effect for the different test sessions ("time"); copy accuracy was better than recall accuracy for both groups (F (1,51)=68.03, p<.001, partial η^2=.85), but no interaction appeared. Figure 2 and Table 2 show the results of the visual memory test regarding accuracy scores for alcohol-dependent patients compared to healthy controls.

If the analysis is not controlled for IQ, but still matched for education and age, the group by time interaction was significant (F (1,40)=4.99, p=.02, partial η^2=.12), i.e., patients performed worse in the visual memory test than healthy controls, controlled only for age, and education.

Table 2: Statistical values in visual memory performance (*M*, *SD* and ANCOVA results) for alcoholics and healthy controls, controlled for age, education and IQ

	Alcoholics (N = 25)		Healthy Controls (N = 15)		ANCOVA (repeated measure)*			
	M	*SD*	*M*	*SD*	F (Huynh-Feldt)	df	p	Partial Eta-squared
Copy	34.77	2.93	35.73	1.03	4.89	1,452	.02	.12
Immediate recall	19.98	7.38	25.17	3.01				
30-min delayed recall	19.75	7.60	25.37	3.36				

*Note: * Copy accuracy was better than recall accuracy for both groups.*

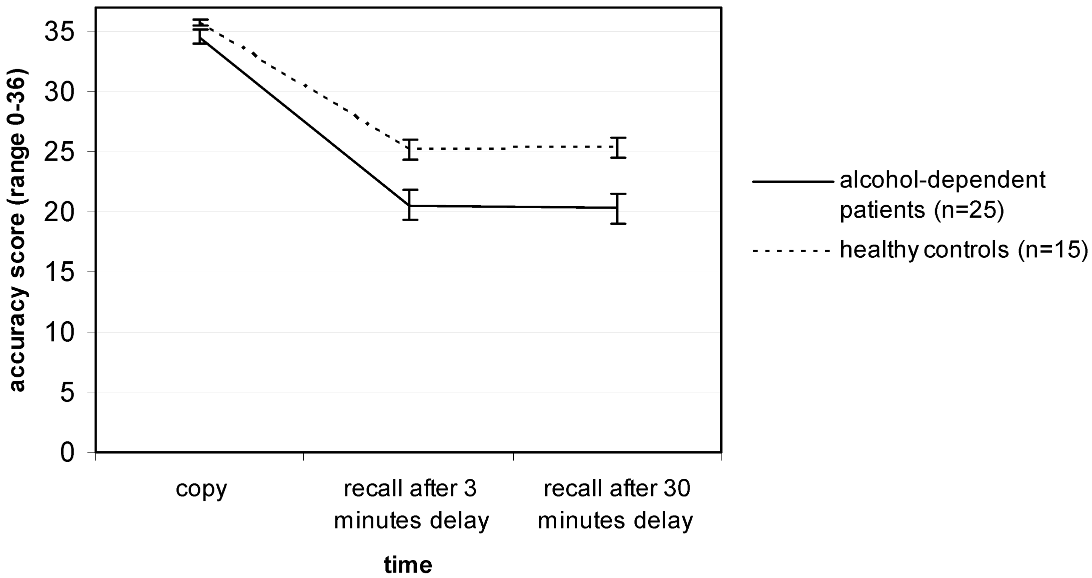

Figure 2: Accuracy scores (*M*, *SE*; *total raw score*) for copy and recall for alcoholics and healthy controls

Group differences in the distribution of organizational strategies in copy and recall

Compared to controls, alcoholics showed a different distribution in organizational strategies at 3-min delayed recall (KS-Z=1.90, p<.01) and 30-min delayed recall (KS-Z=1.42, p<.05). Proportionally, more alcoholics used a less detailed strategy while recalling the figure than did healthy controls. There was no significant difference between controls and alcoholics in the distribution of strategy types while copying the figure (see Table 3). No differences in organizational strategy were found if the analysis was calculated with an IQ-matched subsample (alcoholics n=7; healthy controls n=7), but because of the very little group size, the latter results are only preliminary.

Associations between alcohol consumption and accuracy scores

There was no significant correlation neither between alcohol consumption/duration variables and accuracy scores calculated with Pearson correlation, nor between alcohol consumption/duration variables and strategy scores calculated with one-way Spearman Rho. The correlation between alcohol consumption measured with LDH and IQ was also non significant. Furthermore, there was no significant correlation between IQ and accuracy scores. But there was a significant association between education and immediate recall accuracy (r=.30, p<.02) as well as between education and delayed recall accuracy (r=.34, p<.01), i.e., participants with higher education reached better recall accuracy scores.

Table 3: Percentages of R-OCF typology classification for alcoholics and healthy controls

		Strategies						
		I	II	III	IV	V	VI	VII
Copy	alcoholics (N=25)	56% (N=14)	4% (N=1)	8% (N=2)	28% (N=7)	4% (N=1)	–	–
	healthy controls (N=15)	93% (N=14)	7% (N=1)	–	–	–	–	–
Immediate recall	alcoholics (N=25)	40% (N=10)	8% (N=2)	24% (N=6)	16% (N=4)	12% (N=3)	–	–
	healthy controls (N=15)	100% (N=15)	–	–	–	–	–	–
30-min delayed recall	alcoholics (N=25)	56% (N=14)	8% (N=2)	16% (N=4)	8% (N=2)	12% (N=3)	–	–
	healthy controls (N=15)	100% (N=15)	–	–	–	–	–	–

Discussion

Evidence has shown that acute alcohol consumption as well as early withdrawal and abstinence are associated with an increased likelihood of cognitive impairments such as decreased memory functions, particularly including deficits in visuo-spatial memory [1], [2], [3], [4], [5]. In our study, it was essential to control all calculations for IQ to see if the differences between IQ scores could have influenced the study findings. Studies on recently detoxified alcoholics show constantly impaired cognitive performance in the domains of sustained attention, executive functions, nonverbal memory, and visuo-spatial functions such as visual working memory [10], [11], [12], [14]. It is essential to see if these findings are related to IQ or are the result of other underlying influences. However, initially decreased perceptual clustering, constructional accuracy and use of less efficient problem-solving strategies seem to recover at least partly in alcoholics with long-term abstinence [15].

R-OCF copy performance

Our results showed that alcoholics during early abstinence performed just as well in figure copying as did healthy controls. Copying a figure can be interpreted partially as a short-term memory process [36], and previous studies showed that visual short-term memory was not significantly affected in detoxified alcoholics [17]. Consistent with prediction, performance of the R-OCF figure task did not reveal differences in this kind of short-term memory process between alcoholics and healthy controls, indicating that this part of short-term memory may be unaffected by alcohol dependence. Of course, we cannot exclude the possibility that this specific task might be unfit for detecting subtle short-term memory impairment in alcoholics.

R-OCF recall performance

Our results showed that alcohol dependent patients during very early abstinence perform less well in visual memory recall after three and 30-minutes delay, but so did the healthy controls. The performance of both groups was characterized by a forgetting curve typical of visuo-spatial tests, with lower scores for longer intervals [37]. Interestingly, there was no interaction that indicates that the shown magnitude of the decline of performance from copy to recall differs between the two groups. If the results are controlled for IQ, alcoholics showed no deficient performance in recall compared to controls, if the results were not controlled for IQ, a deficient performance appeared very likely as a consequence of an impaired memory which might be due to a lower IQ. Earlier findings showed impaired performance of a visual memory task in four weeks and four months abstinent alcoholics [25], [37]. Our results could not confirm the results of Zinn et al. [38], who found that abstinent alcoholics performed worse in nonverbal memory. But in contrast to our study, the estimated IQ in Zinn's study was not predictive for memory performance. It seems that forgetting details of the R-OCF figure occurs very quickly in general, within the first few minutes after copying [39].
Studies of long-term abstinent alcoholics did not reveal impaired performance of visuo-spatial memory function and recall performance with R-OCF [24]. Therefore, long term abstinence may operate as a promoting factor for the performance of working memory, at least in the visual domain. However, a number of factors which might not be directly related to alcohol dependence may be responsible for low performance and time dependent recovery. Studies have shown that sons of alcoholic fathers may show executive dysfunctions present at a premorbid state, which may lead to the incorrect conclusion that memory dysfunction may be entirely due to an alcoholism induced process, rather than an underlying trait [40]. Alternately, the imperfect matching of IQ in our study may have had consequences for performance of R-OFC.

However, we speculate that if visual short term memory is not clearly affected in alcoholics, this might be due to the use by alcoholics of different cognitive processes such as a specific organizational strategy, so as to achieve normal performance.

R-OCF organizational strategy

Our results support the hypothesis that alcoholics use a less effective organizational strategy for recalling the R-OCF during early abstinence compared to healthy controls. Contrary to the recalling task, no statistically significant group difference could be found in organizational strategy while copying the figure, tested with the KS-Test. This effect, however, may be due to the low number of participants in our study.

Sullivan and colleagues [25] reported that four weeks abstinent patients used less effective strategies for R-OCF recall than did healthy controls. It might be assumed that a different underlying process must be activated while copying, as learning, consolidating the figure versus recalling the figure. This phenomenon might also be reflected in the group differences of organizational strategy while recalling the figure. Sullivan and colleagues [25] suggested that the combined contributions of copy accuracy and copy strategy accounted for group differences in recall.

Sullivan et al. [25] showed furthermore a significant direct effect of copy strategy on copy accuracy in alcoholics as well as healthy controls. In that study, copy accuracy and copy strategy made independent contributions to recall accuracy. The recall deficit in alcoholics was consequently attributed to impairments in both accuracy and strategy to copy. Therefore, distinct factors may contribute to a deterioration of strategic organization in visuo-spatial memory. A simple deficit in memory could be a factor, but the impairments may also arise due to a less detailed organizational strategy, implicating a deficit in encoding the elements of the figure rather than a deficit in recalling them [25]. Identifying the strategy gives insight into the nature of encoding, as well as its influence on copy and recall accuracy. Healthy controls used a holistic strategy [25], which might be more efficient in the encoding process, in analogy to chunking in verbal memory. Furthermore, premorbid IQ, education and a family history of alcoholism or attentional deficits may also contribute to memory deficits in alcoholics, and may also lead to employment of less effective organizational strategies [13], [40].

Limitations of our study include group differences regarding time-dependency, as temporal conditions have an impact on memory improvement. The longer the time span between learning and recalling, the worse is the memory performance to be expected. Further, it is well known, that neuropsychological recovery is experience-dependent, not only time-dependent [41]. It is still a matter of speculation whether the disruption of reconsolidation causes permanent or transient disturbances of memory function. Evidence suggests that use of illicit drugs is associated with poorer memory performance [42]. We did not take the consumption of different recreational drugs as covariates into account, but note that polydrug abuse is not characteristic of our study population. Also, in our study the participants were not matched for IQ and testers were not blind to diagnosis. Finally, we did not test for inter-rater bias for the three different examiners in this study.

The hallmark of this study is the investigation of visuospatial memory in terms of accuracy and organizational strategies in drug and medication free alcoholics shortly after abstinence has started, but after cessation of clinical withdrawal symptoms. Our results provide evidence that alcoholism has detrimental effects on visuo-spatial organizational strategies at this early phase of abstinence. However, this time point is very critical because once patients stop showing objective withdrawal symptoms their access to high intensity treatment facilities is limited; indeed patients may be discharged at this point. Due to their imperfect organizational strategies, these patients might need auxiliary therapeutic care to strengthen their cognitive ability. We would like to suggest a special kind of teaching for alcoholics to use more efficient strategies, i.e., holistic strategies during encoding procedures also regarding the use of skills for maintaining abstinence. Till today, there is no consistent recommendation for optimized treatment duration, but our results suggest that patients might benefit from therapy lasting longer than ten days after cessation of withdrawal symptoms: In our study alcohol abstinence was enforced between seven and ten days before testing.

Notes

Competing interests

The authors declare that they have no competing interests.

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