VISUAL PERFORMANCE AND RECOVERY IN RECENTLY DETOXIFIED ALCOHOLICS

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Abstract — In order to assess the impact of chronic alcohol misuse on basic visual functions, we investigated motion perception, visual short-term memory, and visual divided attention in recently detoxified patients and matched controls by means of visual psychophysical tasks. Subjects were tested twice within the first 3 weeks of detoxification in order to assess the potential recovery of visual performance. Patients demonstrated significant impairments in visual perception of coherent motion for slow, but not faster, speeds, and in speed discrimination as assessed by random dot kinematograms. Visual short-term memory tested with a delayed vernier discrimination task, on the other hand, was not significantly affected in patients. When processing hierarchical letters, a divided attention task, detoxified patients showed neither impairments in overall attentional capacity nor attentional allocation, but slightly enhanced interference of global information on local target processing. The results of the visual divided attention task contradict the predictions of the ‘right hemisphere’ hypothesis of alcoholism: global target information — mediated by the right hemisphere — was not only accessible to detoxified patients, but seemed to exert an even greater influence on local processing during early detoxification, than in matched controls. Limited recovery within the first 3 weeks was seen only in visual speed discrimination. Recently detoxified patients revealed deficits similar to intoxicated social drinkers in identical tests of visual perception of motion, but not visual short-term memory.

INTRODUCTION

Acute alcohol intoxication has been demonstrated to affect different aspects of vision, e.g. visual acuity for moving stimuli, contrast sensitivity, ocular motor balance, the processing of motion, visual short-term memory, and stereoscopic depth perception (MacCarthony and Tong, 1980; MacArthur and Sekuler, 1982; Hogan and Linfield, 1983; Hill and Toffolon, 1990; Miyao et al., 1994; Watten and Lie, 1996; Wegner and Fahle, 1999; M. Fahle and A.-J. Wegner, in preparation). However, there exist only a small number of studies assessing the effect of chronic alcohol misuse on visual perception. Whereas a few investigations addressed some aspects of visual perception, such as contrast sensitivity or colour vision (e.g. Smith and Brinton, 1971; Smith and Layden, 1971; Cruz-Coke, 1972; Swinson, 1972; Sakuma, 1973; Roquelaure et al., 1995), psychophysical studies on other visual functions, e.g. visual motion perception in subjects with chronic alcohol misuse, are lacking.

On the other hand, alcoholism is known to impair performance in a variety of cognitive functions as assessed by clinical neuropsychological tests. These neuropsychological deficits are often summarized as showing a more severe deficit in visual—spatial than in verbal functions (e.g. Butters et al., 1977; Ryan and Butters, 1980b; Leber et al., 1981; Becker et al., 1983; Donat, 1986; Tarbox et al., 1986; Reed et al., 1992; Fabian et al., 1994). However, most clinical tasks testing visual functions such as visual short-term memory are often not restricted to the visual domain. Mostly, they consist of material, such as geometric configurations or pictures to be remembered or reproduced by the subjects (Ryan and Butters, 1980b; Leber et al., 1981; Becker et al., 1983; Brandt et al., 1983; Donat, 1986; Tarbox et al., 1986; Arria et al., 1991; Reed et al., 1992; Zhang et al., 1997). Therefore, these configurations can often be encoded not only visually, but also verbally, and performance in these tests depends not only on visual memory, but also on the use of, e.g. semantic coping strategies.

In the present study, we assessed basic visual functions in recently detoxified patients with chronic alcohol misuse by means of psychophysical tasks. These tasks are designed to test specific visual functions, thereby limiting coping strategies. The aim of this study was to assess the impact of chronic alcohol misuse on basic visual functions such as motion perception, visual short-term memory and visual divided attention. The following is a background summary of these three tasks.

In the first task, we assessed visual short-term memory in recently detoxified patients and a matched control group by means of a delayed vernier discrimination task. In this test, the discriminative feature of the stimulus, namely the offset of a vernier, can be encoded only visually, thus limiting the use of coping strategies. This psychophysical task — in contrast to the Benton Visual Retention Test — has been demonstrated to be sensitive to the deficits in visual short-term memory during moderate acute intoxication (Wegner and Fahle, 1999).

The second task applied in the present study addressed two aspects of visual motion perception by adapting the paradigms of Newsome and Paré (1988) and Sekuler (1990): speed discrimination and integration of local motion signals in the presence of stimulus noise. These tests are considered to be a sensitive measure of the function of an extrastriate cortical area lying medial temporal (MT), which contributes to the visual perception of motion (Dubner and Zeki, 1971; Zeki, 1974; Maunsell and Van Essen, 1983; Newsome and Paré, 1988). A separate study applying the same tests in acutely intoxicated healthy volunteers (M. Fahle and A.-J. Wegner, in preparation) revealed that speed discrimination was significantly impaired during acute intoxication. In addition, alcohol differentially influenced visual motion perception depending on stimulus speed. These results indicated that alcohol selectively affected the integration of local motion signals for slow (2°/s) but not for faster (10°/s) speeds. This finding can be interpreted within the framework of the concept of two processing streams in visual motion perception. In the

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present study, applying the same stimuli, we investigated whether motion perception is affected by alcoholism and whether the selectivity in deficits observed in intoxicated healthy subjects may be found also in detoxified patients with chronic alcohol misuse.

The third task examined divided visual attention, more specifically, the processing of hierarchical letters, i.e. global letters composed of small local letters. Like the other tasks, this test is also confined to the visual domain, as attention has to be divided between two aspects of one visual stimulus. Since these stimuli have been demonstrated to reveal differential deficiencies in neurological patients, depending on the localization of the cortical lesions (e.g. Robertson and Lamb, 1991), this task can be utilized to test the hypothesis of lateralized cortical impairments in chronic alcoholism.

MATERIALS AND METHODS

Subjects

Nineteen patients with chronic alcohol misuse [16 male, three female; mean age (±SEM) 44.6 ± 2.14 years] and 19 healthy volunteers [nine male, 10 female; mean age 42.2 ± 1.75 years] matched for age and education were tested twice. There were no significant differences between the results of male and female observers. Patients were recruited from the University Hospital of Psychiatry and Psychotherapy in Tuebingen and were examined during the first 4 days of their hospitalization and again 2 weeks later, immediately prior to dismissal. Normal controls were also tested twice within 3 weeks.

Potential participants, patients and controls, were screened using structured questionnaires, including assessment of general demographic information, history and quantities of alcohol consumption, family history of alcoholism or other psychiatric diseases, other drug-taking behaviour (medication, drugs, nicotine) and previously or ever experienced signs of withdrawal.

Patients were included in the present study if they fulfilled the following criteria: diagnosis of alcohol dependence/misuse according to DSM IV (American Psychiatric Association, 1994) and ICD-10 (World Health Organization, 1992), normal or corrected to normal visual acuity, no psychiatric medication during hospitalization (including benzodiazepines), no psychiatric or neurological disorder, and alcohol misuse maintained until hospitalization (in order to assure that all patients were tested within their first week of detoxification), but no current blood alcohol. Patients receiving any psychiatric medication during the first week of detoxification such as benzodiazepines were excluded from the study. Moreover, patients with known histories of withdrawal complications and/or current serious signs of withdrawal were also excluded.

Control subjects with normal or corrected to normal visual acuity and no report of current or past history of alcoholism, neurological and/or psychiatric disease or medication were included. Alcohol-related data of patients and controls are shown in Table 1.

Patients reported a maximum daily consumption of 257 g/day alcohol (SEM 44; range 85–800) and a mean daily consumption of 177 g/day alcohol (SEM 30.12; range 65–600) during the last month and a mean alcoholism history of 7.1 years (SEM 1.6; range 1–25).

Tasks

Visual acuity. This was assessed by means of the Freiburg Visual Acuity Test. From a distance of 2 m, subjects have to indicate the orientation of Landolt-Cs of varying size (Bach, 1995).

Visual motion perception. This was tested by means of random dot kinematograms (Newsome and Paré, 1988). Stimuli were produced with a Silicon Graphics computer Indigo® and consisted of 100 dark (4 cd/m²) dots with a dot size of 8 arcmin randomly distributed on a bright background (80 cd/m²) covering an area of 6 × 6 deg² (i.e. 2.8 dots/deg²). Dots were refreshed every second frame (i.e. every 28 ms). At a viewing distance of 60 cm, all stimuli were presented centrally for 200 ms. No fixation point was provided.

The first test assessed the ability to integrate local motion signals in the presence of motion direction noise. Dot speed was constant at either 2°/s or 10°/s, varied between blocks. The subjects’ task was to report the direction of the coherently moving dots with four directions being possible: up, down, left, or right (four alternative forced choice: 4AFC). The dots constituting the motion direction noise were randomly replaced (Fig. 1).

For threshold measurements, an adaptive staircase procedure (PEST; Taylor and Creelman, 1967) varied the percentage of dots moving coherently in one direction (% coherence). Subjects received a few familiarization trials prior to each threshold measurement.

For the second test, a speed discrimination paradigm, the random dot kinematogram comprised a horizontal row ("stripe"), 1° high, extending over the total width of the stimulus. The stripe was defined by dots moving at a slightly higher speed than the surrounding dots and was located 1° from either the upper or lower border of the stimulus (Sekuler, 1990). All dots moved either in one direction, i.e. to the left or right (unidirectional stimulus) or else half of the dots moved to the right, whereas the other half moved to the left (bidirectional stimulus). Unidirectional and bidirectional conditions were tested in separate blocks for a fixed base speed of 10°/s (Fig. 2). The subjects’ task was to report whether the stripe was in the upper or the lower part of the random dot kinematogram (two alternative forced choice: 2AFC). For the determination of thresholds, the speed difference was varied according to the adaptive staircase procedure (PEST).

Table 1. Summary of the demographic and alcohol-related data for patients and controls

<table>
<thead>
<tr>
<th></th>
<th>Age (years)</th>
<th>Family history of alcoholism (frequency)</th>
<th>First consumption age (years)</th>
<th>Alcohol addiction (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (n = 19)</td>
<td>44.6 ± 2.14</td>
<td>16</td>
<td>15.5 ± 0.75</td>
<td>7.13 ± 1.6</td>
</tr>
<tr>
<td>Controls (n = 19)</td>
<td>42.2 ± 1.75</td>
<td>4</td>
<td>16.6 ± 0.7</td>
<td>—</td>
</tr>
</tbody>
</table>
Subjects’ task was to indicate whether an H or an S (target letters) were either similar to the target letters (H–A; S–E) or dissimilar (H–E; S–A). All eight possible combinations of these letters were applied with the limitation that each compound letter contained one target and one distractor letter (Fig. 3).

Subjects’ task was to indicate which of the two target letters, i.e. H or S, had been presented — either on the global or local level. The key for H had to be pressed by the right, the one for S by the left, index finger. Subjects were instructed to attend to both target levels and to react as fast and as correctly as possible. Before data collection, subjects performed practice trials, which were excluded from further analysis. Individual median RTs (ms) of correct trials and the percentage of errors were recorded. Reaction times longer than 2 s were excluded from further analysis.

**Biasing.** The frequency of the target letters appearing on both target levels (global or local) was manipulated, yielding three conditions: In the no bias condition, target letters (H or S) were equally often presented on the global and local level. In the global bias condition, 75% of the target letters appeared on the global level, whereas in the local bias condition, 75% of the target letters were presented on the local level.

Bias conditions were measured in three separate blocks of 64 presentations each. The order of bias conditions was either ‘local bias–no bias–global bias’ or ‘global bias–no bias–local bias’, randomized between subjects. Subjects were not informed about biasing.

**Distractor effect.** In the present study, H and S were the target letters and A and E served as distractors. These letters were chosen since A is similar to H but less than to S, whereas E is similar to S but less than to H. Thus, for each target letter, there exists one similar (H–A; S–E) and one dissimilar (S–A; H–E) distractor letter (Robertson et al., 1988; Lamb et al., 1990; Giersch et al., 1997). The distractor effect refers to the observation that reaction times to local targets were faster if the local target letters (H or S) compose a similar global distractor letter (A or E). Classically there is no such effect for global target letters.

**Visual short-term memory: delayed vernier discrimination**

This test assesses visual short-term memory using very simple visual stimuli, i.e. verniers (Faehle and Harris, 1992). The vernier target consisted of two vertical lines, each 50 arc min long and 2 arc min wide with a 0.5 arc min vertical gap between them. The lower segment was always displaced to the right by either 580, 620 or 740 arc s. The first vernier was presented for 100 ms on an analogue monitor under computer control. After a delay of 1 s, a second vernier with either a smaller or a larger offset was presented for 100 ms at about the same position as the first (Fig. 4).
The subjects' task was to indicate which time interval contained the larger vernier offset by pressing one of two buttons (temporal two alternative forced choice task).

Thresholds were determined by the adaptive staircase procedure (PEST), i.e. test stimuli became more similar and therefore harder to discriminate as long as subjects' answers were correct. On the other hand, a level answer led the staircase procedure to present more easily distinguishable stimuli. This adaptive procedure converged to a stimulus configuration yielding 75% correct responses, which is taken as the subjects' discrimination threshold.

Initial orientation of the stimulus was either horizontal or vertical, counterbalanced between observers. For the second session, the orientation of the vernier was changed by 90°. Previous studies (Poggio et al., 1992) have shown that changing the orientation of the vernier by 90° prevents transfer of improvement to the new orientation.

**Analysis**

For the data of the visual acuity, motion, and visual short-term tasks, a repeated measurements analysis of variance (ANOVA) was calculated using ‘group’ (patients–controls) as between subjects factor, and ‘session’ (first–second testing) as within factor. For the divided attention task data, a repeated measurement ANOVA, with ‘group’ (patients–normals) as between factor and ‘session’ (first–second testing), ‘target level’ (local–global), ‘bias condition’ (global bias, local bias, and no bias), and ‘distractor similarity’ (similar–dissimilar) as within factors was calculated. In addition, we correlated RTs and error data in order to detect possible speed–accuracy trade-offs, i.e. a decrease in RTs at the expense of the error rate.

**RESULTS**

**Visual acuity**

In patients, visual acuity was slightly but not significantly worse than in healthy controls ($P > 0.4$). Both groups demonstrated a small, but insignificant, improvement in visual acuity at the second testing (both $P > 0.2$).

**Integration of local motion**

For the slow speed tested ($2^\circ/s$), alcoholic patients required significantly higher coherence thresholds (%) than normal controls, both in the first and the second sessions ($P = 0.0022$ and $P = 0.16$, respectively; Fig. 5). Neither group significantly improved in the second examination (both $P > 0.2$).

However, patients and controls did not differ in thresholds for the faster speed applied ($10^\circ/s; P > 0.9$). In the first session, patients performed worse than controls, whereas in the second session, they yielded slightly lower thresholds than normal controls. In patients, the improvement approached significance ($P = 0.08$).

**Speed discrimination**

For the unidirectional stimuli, patients’ thresholds were significantly elevated as compared to those of normal controls, both in the first and the second session ($P = 0.005$ and $P = 0.01$, respectively; Fig. 6). The patients, but not the normal controls, significantly improved in the second session ($P = 0.03$ versus $P > 0.1$, respectively).

Thresholds of patients did not differ significantly from those of controls ($P > 0.3$) for the bidirectional stimuli. Normal controls, but not patients, demonstrated a slight, but insignificant improvement when tested for the second time ($P = 0.14$).
**Divided attention**

Overall reaction times did not differ between normal controls and patients \( (P > 0.4) \). Thus patients did not show a significant overall increase in reaction times. However, during the second session, both groups reacted faster by an average of 50 ms \( (P = 0.001) \).

Neither patients nor controls demonstrated a speed–accuracy trade-off indicative of a strategy favouring either speed at the expense of accuracy or vice versa. [These results are in accordance with findings of Glenn and Parsons (1991) who reported a similar speed–accuracy relationship both in alcoholic patients and controls if both factors were emphasized in the task instructions.]

Error rates were significantly higher in patients than in controls, only for the first examination \( (P < 0.0001 \text{ and } P > 0.3 \text{ in the first and second session, respectively}) \). Patients, but not controls, yielded significantly lower error rates in the second examination \( (P < 0.0001 \text{ versus } P = 0.17) \). However, mean error rates were low \((3.7\% \pm 0.3 \text{ and } 5.1\% \pm 0.4 \text{ in controls and patients, respectively})\).

**Biasing**

Both in controls and patients, we found a significant bias effect \( (both \ P < 0.0001) \), i.e. a faster reaction to the more often presented target level (Fig. 7). In the local bias condition with 75% of the targets presented on the local level, both groups reacted faster to the local, i.e. biased, level. Similarly, in the global bias condition, subjects reacted faster to global targets. Finally, in the no bias condition with equal probability of both target levels, subjects had similar RTs to both levels (Fig. 7).

Whereas in the local bias condition, RTs of both groups were indistinguishable in both sessions, subjects mainly improved in the global and no bias condition, i.e. RTs in these conditions decreased in the second examination. In the no bias condition, RTs of both groups became even more similar, whereas in the global bias condition, RTs of both groups diverged, with a greater decrease of RT in normal controls.

**Distractor effect**

The similarity of the distractor affected the RTs to local targets, i.e. subjects reacted faster to local targets with similar distractors than with dissimilar distractors \('target level' \( \times \ 'similarity' \): \( P = 0.03 \) and \( P = 0.0026 \) in normal controls and patients, respectively) (Fig. 8). The interactions of \('target level' \( \times \ 'similarity' \) \( \times \ 'session' \) and \('target level' \( \times \ 'similarity' \) \( \times \ 'group' \) were not significant, indicating that the distractor effect did not differ between examinations or groups (Fig. 8).

**Visual short-term memory**

Thresholds in delayed vernier discrimination did not significantly differ between normal controls and patients \( (P > 0.5) \), neither in the first, nor the second examination (Fig. 9). Inter-individual differences were high: in controls, thresholds ranged from 23 to 145 arc s \( (\text{mean} \pm \text{SEM} 66.3 \pm 6.9) \) in the first and from 18 to 102 arc s \( (47.3 \pm 5.2) \) in the second examination. In patients, thresholds ranged from 22 to 200 arc s \( (69.3 \pm 10.7) \) and from 22 to 205 arc s \( (55.5 \pm 9.6) \) in the first and second examinations, respectively.

The normal controls, but not the patients, yielded significantly lower thresholds in the second than in the first examination \( (P = 0.032 \text{ versus } P < 0.3, \text{ respectively}) \).
Patients were impaired in the discrimination of speed differences, when compared to normal controls. This impairment was significant only for unidirectional, but not for bidirectional, stimuli. Thus, in the easier task, patients showed deficiencies, whereas they performed as well as controls in the more difficult speed discrimination task. These results reflect the fact that the normal controls were quite good in the unidirectional speed discrimination task, but yielded elevated thresholds in the bidirectional stimuli when shown for the first time (see ‘Recovery of speed discrimination’ below).

**Divided attention**

Robertson and Lamb (1991) proposed a model composed of four subsystems for the processing of hierarchical stimuli, suggesting that the global level of the stimulus is predominantly processed in the right posterior superior tempo-parietal regions, whereas the local level is mainly processed in its left counterpart. Damage to one of these regions causes RT advantages for one level at the expense of the other target level. A third subsystem controls attention, as assessed, e.g. by the biasing paradigm, and is thought to be associated with the lateral parietal lobes of both hemispheres, while the fourth combines information from both hemispheres. Thus, one might assume that distractor effects rely on the normal (asymmetric) coordination of the information from both hemispheres, resulting in global or local interference. In responding to these hierarchical letters, patients were not impaired in overall RTs, as compared to normal controls matched for age and education. Thus, chronic alcohol misuse does not seem to slow overall processing and reaction to visual stimuli.

However, during the first session, error rates were increased in patients, but decreased to levels reached by control subjects during the second examination. Thus, attentional capacities seemed to be only initially impaired in patients during early detoxification as indicated by elevated error rates, but to recover within 3 weeks of abstinence. These results are in contrast to the study by Smith and Oscar-Berman (1992) reporting decreased attentional and/or perceptual resources in patients even after more than 4 weeks of abstinence. The discrepancy may be due to a shorter period of alcohol misuse reported by the patients in the present study, i.e. 7.13 years in the present as compared to 23 years in the above study, which would be expected to have less severe consequences (e.g. Butters et al., 1977; Ryan and Butters, 1980a) with shorter lasting attentional deficits.

**Attentional allocation: biasing paradigm**

If the target letter is more often presented on one than on the other level of the hierarchical stimulus, i.e. during biased presentation, RTs to the ‘biased’ level decrease, whereas RTs to the ‘unbiased’ level slightly increase as compared to the no bias condition (biasing effect). This effect may be explained by attentional allocation: the reaction to the more frequently presented target level is faster due to a shift in attention to the biased level, at the expense of the less-often presented target level. Allocation of attention, as assessed by the present biasing paradigm, was not adversely affected in detoxified patients with chronic alcohol misuse. As in normal controls, RTs of patients to the biased level were faster than to the non-biased target level. In addition, RTs to the local and global
target levels were about equal in the no bias condition, i.e.
with equal probability of both target levels.

These results seem to contradict the findings of Robertson
et al. (1985) and Kramer et al. (1989), who reported a prefer-
ence of alcoholic patients to attending to the local, rather than
to the global, level. However, in the Robertson et al. (1985)
and Kramer et al. (1989) studies, there existed no correct or
incorrect reactions, only subjective judgements based on
either the local or global level of the stimulus, and patients had
longer histories of alcohol misuse. Hence, there may be a
spontaneous preference for the local level, but, on demand,
patients can shift attention between levels as well as do normal
controls.

Cortical hemispheres do not seem to be asymmetrically
affected in alcoholism, since alcoholic patients, like controls,
yielded similar RTs to both the local and global target levels
in the no bias condition. In addition, patients demonstrated a
normal pattern during biasing, with no overall preference for
the local level, as would be expected on the basis of the ‘right
hemisphere theory’ of alcoholism. Moreover, the distractor
effect was slightly enhanced in patients (see below), indicating
that local processing seems to be even more affected by
the similarity of the global distractor than in controls. If one
assumes, on the other hand, a deficient global processing due
to right hemispheric impairments, the distractor effect should
be diminished or even abolished, since the global pattern should
no longer influence the local judgement.

Interference: distractor effect

The classical distractor effect observed with hierarchical
letters implies that the processing of the local, but not the
global, target level is affected by the similarity of the distractor
letter: if the global distractor is similar to the local target letter,
RTs are faster than with a dissimilar distractor. In the present
study, this kind of interference was quite similar both in
normal controls and patients. The distractor effect is thought
to be mediated by the (asymmetric) combination of informa-
tion from both hemispheres and is probably processed in both
posterior temporal areas (Robertson and Lamb, 1991). Thus,
the qualitatively normal distractor effect in patients indicates
a normal coordination of global and local information from
both hemispheres. However, the small quantitative differences
observed in recently detoxified patients may indicate a larger
than normal influence of global information, processed in the
right hemisphere, on local processing in the left hemisphere
during the early phase, i.e. the first days of detoxification,
opposite to the predictions by the theory of right hemispheric
deficits in alcoholism (see also below).

Visual short-term memory

This psychophysical task, restricted to visual encoding,
thereby preventing semantic coping strategies, was very sen-
sitive in revealing visual short-term memory loss during acute
alcohol intoxication (Wegner and Fahle, 1999), i.e. intoxicated
healthy subjects yielded significantly elevated thresholds as
compared to sober subjects. These results are at variance with
the present findings in patients demonstrating no significant
impairments, as compared to normal controls. Comparisons
with reference thresholds determined for the same task (Fahle
and Harris, 1992; Wegner and Fahle, 1999) indicated that
thresholds of the normal controls in the present study were
higher than usually observed, especially in the first examination,
and thus not significantly different from those of patients. A
correlation between discrimination thresholds and subjects’
age revealed no systematic change in thresholds with age,
neither in patients, nor controls ($P > 0.7$ and $P > 0.1$, respect-
ively), excluding an explanation based on age differences.

Recovery of visual motion perception

In order to detect potential recovery of visual functions
during the first weeks of detoxification, patients were retested
after 3 weeks of controlled abstinence. To account for possible
learning effects, controls were also retested 3 weeks later.
For both speeds tested, patients improved more than controls
($P < 0.004$ versus $P > 0.18$). The difference approached sig-
nificance only for the higher ($10^\circ$/s; $P = 0.08$), but not for the
slower speed tested ($2^\circ$/s; $P > 0.2$). Controls yielded remark-
ably similar mean thresholds in both sessions, indicating
that practice effects in this task were limited. Thus, the small
improvement observed in patients might suggest some recovery
in visual motion processing, but even in the second examination,
patients performed significantly worse than controls in the
$2^\circ$/s, but not the $10^\circ$/s, motion integration task. In summary,
despite limited recovery in visual motion perception during
controlled abstinence, the visual pathway for slow motion
speeds remains selectively impaired in alcoholism.

Recovery of speed discrimination

In the unidirectional speed discrimination task, patients
significantly improved between sessions, whereas the small
reduction in thresholds of the control group did not reach
significance. These results indicate some recovery beyond the
practice effect in this speed discrimination task, but patients
still yielded significantly higher thresholds than controls in
the second session. In the second session of the bidirectional
condition, controls improved thresholds, indicating a small
learning effect ($P = 0.14$), but patients did not. The difference
in thresholds between patients and controls failed to reach
significance ($P = 0.19$), mainly due to the elevated thresholds
of the controls, especially during the first examination (see
above).

Recovery of divided attention

Mean RTs improved in the second session by about 50 ms,
both in patients and controls, especially pronounced in the no
bias ($P = 0.16$ and $P = 0.009$, in controls and patients, respec-
tively) and global bias conditions ($P < 0.0001$ and $P = 0.06$
in controls and patients, respectively), whereas in the local bias
condition, both groups had very similar RTs in both sessions
(both $P > 0.2$). In the global bias condition, RTs decreased
more in response to local than to global targets, slightly reducing
the biasing effect in this condition (Fig. 7). Patients, but not
controls, yielded lower error rates in all bias conditions (all
$P < 0.003$ in patients; all $P > 0.15$ in controls), indicating a
larger effect of practice in patients. The biasing effect was
slightly reduced during the second examination in the global
bias condition, since RTs of both groups decreased more for
local, than for global, targets (Fig. 7). The effect was signifi-
cant in controls, but the same tendency was present in patients.

These results cannot be explained by a general decrement
in RT to local, as compared to global, targets in all second
examinations, since the decrease was specific for the global
bias condition. Thus, whereas RTs in the no bias condition and the local bias effect were unaffected, the biasing effect in the global bias condition slightly diminished due to practice. In the first examination, patients exhibited an increased distractor effect (i.e., the difference in RTs for local targets with dissimilar versus similar global distractors was 115 ms), as compared to normal controls (84 ms). In the second session, this discrepancy disappeared, i.e., both groups yielded about the same distractor effect (81 versus 82 ms).

**Recovery of visual short-term memory**

In the delayed vernier discrimination task assessing visual short-term memory, both groups improved in the second, as compared to the first, examination. However, the decrease in discrimination thresholds was significant only in controls \((P = 0.03)\), but not patients \((P > 0.3)\). The groups did not differ significantly in visual short-term memory. This large practice effect had not been observed in a previous study applying the same task in sober and intoxicated social drinkers (Wegner and Fable, 1999). It remains unclear why the control group in the present study significantly improved performance after training, whereas the control group of the previous study failed to do so.

In summary, the present results on the influence of chronic alcohol misuse on visual functions as assessed by psychophysical tasks indicate a deficit in visual motion processing, more specifically impairments in integrating local motion signals employed to perceive coherent motion in the presence of stimulus noise. As in acutely intoxicated social drinkers, this deficit was restricted to slow motion speeds (2°/s), arguing for a selective alcohol-related impairment in the visual stream projecting sequentially from the LGN via V1 to MT, but not the stream projecting from the LGN to both V1 and MT in parallel. Moreover, speed discrimination as assessed by random dot kinematograms remained impaired during the first 3 weeks of detoxification in patients. By contrast, visual short-term memory as tested with a delayed vernier discrimination task was not significantly deteriorated in patients as compared to matched controls. The failure to detect a significant loss in visual short-term memory was particularly due to large interindividual differences in both groups.

To summarize the results for the visual divided attention task, both groups (recently detoxified patients and matched normal controls) demonstrated a qualitatively and quantitatively similar processing of hierarchical letters, more specifically a similar attentional capacity and capability of attentional allocation as revealed by their patterns of RTs in the bias conditions. They also showed a similar degree of practice effects. However, one exception to this correspondence between both groups was observed regarding the distractor effect, which was slightly increased in patients as compared to controls during the first session, but normal during the second examination. These results indicate that, in recently detoxified patients, the coordination of information from both hemispheres may initially be altered, resulting in an enhanced global interference on local processing. This effect seems to ‘recover’ to normal levels of interference within 3 weeks of controlled abstinence. The ‘right hemisphere’ hypothesis, stating that mainly right hemispheric functions are impaired in patients with chronic alcohol misuse, would predict: (a) faster RTs to local target levels (processed in the left hemisphere) than to global levels (processed in the right hemisphere); (b) a reduction in interference of global information (right hemisphere) with local processing (left hemisphere). The present pattern of results, i.e., no preference in RTs for a certain target level together with the enlarged distractor effect, contradicts the predictions of the ‘right hemisphere’ theory of alcoholism.

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