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Automatic Temporal Order Judgment: The Effect of Intentionality of Retrieval on Closed-Head-Injured Patients*

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ABSTRACT

Closed-head-injured (CHI) and control groups were tested on a temporal order task under intentional and incidental retrieval conditions. Subjects were given five presentations of a list of nouns. In the incidental retrieval condition, subjects were told that they were to remember the words but that the order was not important. In the intentional retrieval condition, subjects were given the words in an order different from that in which they were originally presented and were asked to reorder the words to match the original order. For both conditions we compared the order in which words were recalled to the order in which they were originally presented. The results suggest that temporal order memory had more effortful characteristics in the intentional than in the incidental retrieval condition. The two groups did not differ significantly in the incidental retrieval condition. However, while the control group showed a significant improvement in the intentional retrieval condition, CHI groups performance did not significantly change. This study highlights two major points: (1) intentionality at the retrieval stage determines the effortfulness with which information is processed; (2) the more automatic the tasks, the better it is preserved following closed-head injury.

Some investigators have attributed memory failure in amnestics to a specific impairment of temporal order judgment (Huppert & Piercy, 1976; Winocar & Kinsbourne, 1978). Hirst (1982) claimed more generally that amnesia results from a breakdown in encoding of contextual information, including temporal order. Moreover, Hirst claims that contextual information normally is encoded automatically, whereas target information is encoded effortfully. Thus, according to this approach, amnesia results from dysfunction of automatic processes. Hasher and Zacks (1979) argued that judgment of temporal order, spatial location

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and frequency of occurrence is an automatic process. They did not test this claim with brain-injured patients, but suggested that these automatic processes may be impaired by neuropathology. Vakil and Tweedy (1985) showed that judgment of temporal order, spatial location and frequency of occurrence were in fact impaired in individuals with closed-head injuries (CHI) and in a group of normal elderly subjects. Milner (1971), Kohl and Brandt (1985) and Janowsky, Shimamura, and Squire (1988) found a specific impairment in judgment of temporal order following frontal-lobe lesion.

Explicit retrieval of information was required in the paradigms which Hasher and Zacks (1979) claimed to require automatic processing. Naveh-Benjamin (1987), Zacks, Hasher, and Alba (1984), and others have raised the possibility that the retrieval stage in the judgment process may be performed effortfully, thus explaining the effortful characteristics which they found in these tasks. In order to control for the attentional demands in the retrieval stage, Vakil and Blachstein (1990) introduced a distinction between intentional and incidental retrieval. The latter condition enabled the investigators to measure memory of temporal order without requesting subjects to explicitly (effortfully) retrieve the information. It is expected that, when subjects are given explicit instructions (intentional condition), the underlying retrieval process is effortful, but when given implicit instructions (incidental condition), automatic processes will be activated in retrieval. Vakil and Blachstein's (1990) findings justified the distinction between the two types of retrieval. As expected, judgment of temporal order showed more effortful characteristics in the intentional, as opposed to the incidental retrieval condition; that is, performance correlated significantly with age, education, and other memory tasks in the intentional condition.

These findings call for a reexamination of the conclusion that automatic processes are impaired following head injury. The findings that head-injured patients are impaired in temporal order judgment (Hirst, 1982; Kohl & Brandt, 1985; Janowsky, Shimamura & Squire, 1988; and Vakil & Tweedy, 1985), are not conclusive since at least one component of the task was actually effortful and thus can't be regarded as a test of automaticity.

The purpose of the present study is to test the temporal order memory of closed-head-injured (CHI) patients in an incidental retrieval condition, avoiding the effortful retrieval component, as well as in intentional retrieval condition. It is our hypothesis that temporal order judgment following head injury is better preserved under incidental than intentional retrieval conditions.

METHOD

Subjects

Two groups of subjects participated in the present study: a control group (non-brain-damaged) and a closed-head-injured (CHI) group. The control group consisted of 35 volunteers who ranged in age from 18 to 54 years (mean 29); their education ranged from 8 to 16 years (mean 12). The CHI group was composed of 35 patients whose age ranged

from 19 to 45 years (mean 29); their education ranged from 8 to 15 years (mean 11). The CHI group were patients who underwent neuropsychological evaluation at the National Institute for Rehabilitation of the Brain Injured, Tel Aviv, Israel.

Test and procedure

A Hebrew version of the Rey Auditory-Verbal Learning Test (AVLT) was used. Administration was standard, as described in Lezak (1983) for the English form. The test consisted of 15 common nouns which were read to the subject for five consecutive trials (Trials I to V). Each trial was followed by a free recall test. The words were read always in the same order without mentioning the importance of temporal order. In Trial VI an interference list of 15 new common nouns was presented, followed by a free recall of these new nouns. In Trial VII subjects were asked to recall again the first list. Twenty minutes later subjects again were asked to recall the first list (Trial VIII). For Trial IX, they were asked to identify the 15 words of the first list when embedded in a list of 50 words, (which included also the 15 words of the second list and 20 new common nouns). An additional trial (Trial X) to the standard administration was added (see Vakil & Blachstein, 1990). At Trial X, following the recognition task, subjects were given the 15 words of first list written in an order different from that in which they had heard them originally. Subjects were asked to rewrite the words in their original order.

The measure of incidental retrieval consisted of the order in which the words were recalled in Trial V, as compared to the order in which the words were read originally; in this condition, during learning and recall phases subjects were told that temporal order was not important.

As a measure of intentional retrieval, we compared the order in which words were presented originally to the order in which the words where rewritten by subjects in Trial X; in this condition subjects were specifically instructed that temporal order was important.

RESULTS

The mean number of words recalled in Trial V (out of 15 words) by the CHI subjects was 9.97 ($SD = 2.72$), while by the control group it was 13.94 ($SD = 1.16$).

For the analysis of temporal order judgment Pearson product-moment correlations were calculated for each subject, comparing the recalled order and the order in which the words were originally presented (Tzeng, Lee, & Wetzel, 1979). Temporal order judgment was evaluated for incidental retrieval (Trial V) and intentional retrieval (Trial X).

Judgment of temporal order as reflected in correlation scores for the two retrieval conditions was significantly above chance for most of the subjects in the control group and for about half of the CHI group. In the incidental retrieval condition 69% of the control group and 46% of the CHI group reached a temporal order score significantly above chance. In intentional retrieval 91% of the control group and 51% of CHI group performed significantly above chance.

Temporal order scores of the two groups (CHI vs. control) under the two retrieval conditions (intentional vs. incidental) were subjected in MANOVA with repeated measures on the second factor. Analysis of the results shows that the main effect for group is significant; the control group performed better than the CHI group (F (1,68) = 16.8, $p < .001$). However, while the main effect of the

retrieval condition was not significant (F (1,68) = 2.36, $p > .05$), the more important group by retrieval condition interaction was found to be significant (F (1,68) = 7.16, $p < .01$).

As can be seen in Figure 1, this interaction is due to the fact that, while control subjects improved significantly when retrieval was tested under intentional compared to the incidental condition from .62 to .78, the CHI group's performance decreased under the intentional retrieval condition from .52 to .48.

Correlations between the intentional and incidental temporal order measures with different Rey AVLT scores for the CHI and control groups are presented in Table 1.

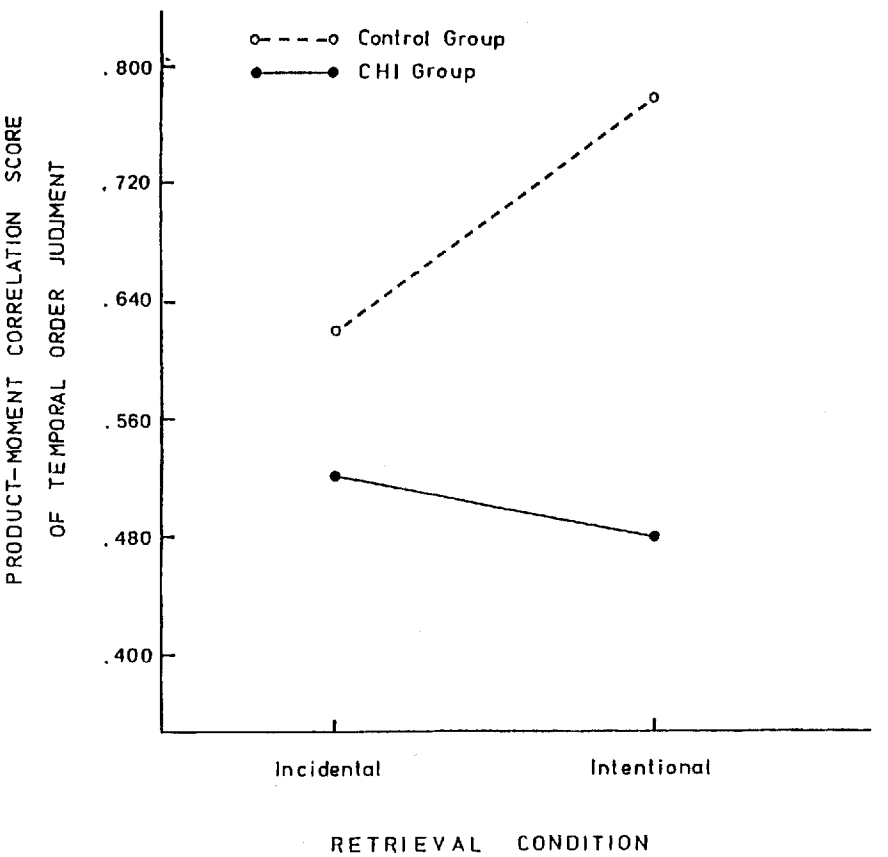

Fig. 1. Correlation score of presented and retrieved temporal order for the different retrieval conditions for CHI and control groups.

Table 1. Correlations Between Scores of Temporal Order Judgment Under Intentional and Incidental Retrieval Conditions with other Rey AVLT Scores for CHI and Control Groups.

	Control group (n = 35)		CHI group (n = 35)	
	Retrieval condition			
Scores	Incidental	Intentional	Incidental	Intentional
T1	.138	.385	.089	.300
T2	.174	.531**	.268	.412*
T3	.038	.480**	.367	.461*
T4	.196	.513**	.072	.635**
T5	−.012	.506**	.054	.495*
T6	−.156	.423*	.042	.462*
T7	.229	.493*	−.066	.589**
T8	.276	.506**	−.030	.591**
TL	.111	.577**	.169	.579**
PI	.273	−.120	.125	−.185
RI	−.311	−.280	.027	−.222
DL	−.377	−.354	−.035	−.262

T1 to*T5* =Trials I to V;
T6 = Trial VI (List B);
T7 = Trial VII (recall following interference);
T8 = Trial VIII (Delayed Recall);
TL = Total Learning (sum of Trials I to V);
PI = Proactive Interference (Trial I - Trial VI);
RI = Retroactive Interference (Trial V - Trial VII);
DL = Delay (Trial V - Trial VIII);

* $p < .05$. ** $p < .01$.

As can be seen in Table 1, temporal order scores under the intentional retrieval condition correlated significantly with most of the Rey AVLT scores (8 out of 12 scores) for both the control and the CHI groups. In contrast, the temporal order scores for both groups under the incidental retrieval condition did not significantly correlate with any of the Rey AVLT scores.

As can be seen in Table 2, for the control group under intentional, but not incidental conditions, the temporal order score significantly correlated with age (the older the worse the performance) and education (the higher the better the performance). For the CHI group under both intentional and incidental conditions, the correlation between the temporal order scores with age and education where not significant.

Table 2. Correlations Between Scores of Temporal Order Judgment Under Intentional and Incidental Retrieval Conditions with Age and Education for CHI and Control Groups.

	Control group (n = 35)		CHI group (n = 35)	
	Retrieval condition			
Scores	Incidental	Intentional	Incidental	Intentional
Age	.161	-.416*	-.070	-.083
Education	.164	.593**	-.059	.087

* $p < .05$ ** $p < .01$.

DISCUSSION

Temporal order judgment under incidental learning and under both intentional and incidental retrieval conditions was significantly above chance for most subjects. This finding was interpreted to support the claim that temporal order is processed automatically (Hasher & Zacks, 1979). The control group and the CHI group showed a similar pattern of significant correlations between temporal order judgment and the other memory tasks only under the intentional retrieval condition. Significant correlations between frequency of occurrence and effortful tasks was interpreted by Tweedy and Vakil (1988) to indicate an effortful component to putative automatic tasks. Thus, the pattern of correlations found here suggests that both groups of subjects processed temporal order effortfully when required to retrieve this information intentionally. This conclusion explains the finding in the control group that only under intentional retrieval conditions was performance correlated with age and education. Hasher and Zacks (1979) did not expect age and education to be related to "innate" automatic processes such as temporal order in normal subjects. However, under the incidental condition there was not such a pattern of correlations in the CHI group. A possible explanation is that the impact of brain injury on memory was stronger than the effect of age and education.

As presented in Figure 1, control and CHI groups did not differ significantly in the incidental retrieval condition. However, the control group showed a significant advantage under the intentional retrieval condition, while the CHI group did not change significantly.

Since temporal order judgment in the incidental retrieval condition was performed for words recalled in the fifth trial, it may be argued that similarity in performance between the groups is due to the fact that the CHI group recalled fewer words, thus perhaps simplifying the judgment of temporal order. This argument is rejected since in the incidental retrieval condition no significant correlation was found between number of words recalled and temporal order judgment.

With regard to the controversy in the literature as to whether automatic processes are preserved following CHI (see Meudell & Mayes, 1982 for review), our findings indicate that automatic processes are better preserved than effortful processes. In light of the present findings, we argue that it is premature to conclude that automatic processes are impaired following CHI, based on impaired performance in temporal order judgment, since prior studies failed to differentiate between intentional and incidental retrieval (Hirst, 1982; Vakil & Tweedy, 1985).

The fact that performance under incidental retrieval was better preserved, can perhaps explain the residual memory skills found in amnesic individuals (Parkin, 1982). Most of these preserved skills described by Parkin (1982), did not require an intentional retrieval.

In conclusion, the results of this study reconfirm the importance of distinguishing between intentional and incidental retrieval conditions. The different retrieval instructions had a clear effect on the way both groups processed the information. Future research should take into account the effect of intentionality, not only at the encoding stage, but at the retrieval stage as well. This distinction is also useful in neuropsychological assessment. It calls for more attention to the particular instructions regarding retrieval of information.

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