Exemplar Verification of Goal-derived Categories with Closed-head-injured Adults

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Individuals who have suffered closed head injuries (CHI) have been observed having difficulty with discrimination, retrieval, and information recognition. These skills are needed for information categorization, which is a primary source of data on these individuals' knowledge of concepts (Adamovich, Henderson, & Auerbach, 1985; Beukelman & Yorkston, 1991; Brooks, 1990; Obrzut & Hynd, 1990; Ylvisaker & Szekeres, 1986).

The category type examined and the specific task used may influence the categorization-skill performance of adults with CHI. Common categories are natural object concepts that have graded structure such as "weapons," (Rosch, 1975; Rosch & Mervis, 1975). This indicates that not all category members equally represent the category, with some members being better examples than others and considered to be more typical. On a category verification task, Grober, Perecman, Kellar, and Brown (1980) found that subjects with posterior aphasia demonstrated difficulty with categorization of atypical and related nonmembers. Hough (1988; Hough & Pierce, 1989) observed that adults with fluent and nonfluent aphasia were as accurate as non-brain-damaged subjects in identifying common category examples but consistently required significantly more time to verify category members. In an exemplar generation task with CHI adults, Lohman, Ziggas, and Pierce (1989) found that although the brain-damaged subjects produced significantly fewer total common category exemplars than normal controls did, there was no significant difference between groups on category mean typicality ratings.

Barsalou (1983; 1987) investigated the structure of goal-derived categories used in specialized contexts. They are instrumental to achieving goals, such as "things to take on a picnic." They also possess graded structures

but are not as established in memory as common categories because people have had less experience with them as categorical concepts. On a category verification task with fluent and nonfluent aphasic and non-brain-damaged adults, Hough and Pierce (1989) observed a similar performance with accuracy of identification of category members for goal-derived categories; that is, aphasic adults were as accurate as non-brain-damaged subjects in identifying goal-derived category examples but consistently required significantly more time to verify category membership. On an exemplar generation task with CHI adults, Hough, DiFilippo, Pierce, and May (1990) found that although high-functioning closed-head-injured subjects produced significantly more total responses than normal controls, there was no significant difference between these two groups in the number of correct category responses produced. The CHI subjects produced many out-of-set responses. However, there was no significant difference between groups on their in-set category mean-typicality ratings.

The present study examined the verification of goal-derived category exemplars by CHI adults and non-brain-damaged controls. Specifically, accuracy in identifying category exemplars and nonmembers was examined. Furthermore, the authors were concerned with the CHI subjects' sensitivity to the graded structure of the in-set category members. This study is part of a larger investigation examining several aspects of categorization skills of CHI adults at various levels of functioning.

METHOD

Subjects

Twenty adults participated. Ten had a history of significant closed head injury as the result of automobile or motorcycle accidents, and ten were free of neurological insult and history of mental deterioration. The closed-head-injured and non-brain-damaged subjects were matched on gender. The CHI adults were functioning at either Level 7 or 8 on the Ranchos Los Amigos Levels of Cognitive Functioning Scale (Hagen & Malkmus, 1979). Furthermore, all deficits were considered chronic as all the CHI subjects were at least 18 months post-injury. Subject characteristics for the CHI and non-brain-damaged groups are presented in Table 1. The closed-head-injured and non-brain-damaged groups did not differ significantly in age ($p > .10$). Education levels were not compared between the two groups because the education programs among many of the subjects with closed head injury were interrupted by their injury.

TABLE 1. CLOSED-HEAD-INJURED (CHI) AND NON-BRAIN-DAMAGED (NBD) SUBJECT CHARACTERISTICS

Subjects	*Gender*	*Age*	*Education*[a]	*MPI*[b]	*Coma*[c]
CHI					
1*	M	28	16	53	28
2	M	24	12	65	3
3	M	25	11	98	35
4	M	22	14	32	42
5	M	34	14	76	1
6	M	20	12	19	7
7	M	42	17	108	3
8	F	30	12	85	26
9	F	25	12	18	14
10	M	22	12	18	2
Range		20–42	11–17	18–108	1–42
Mean		27.2	13.2	57.2	16.1
Standard Deviation		6.66	1.99	34.35	15.37
NBD					
11	M	27	18		
12	M	24	16		
13	M	25	14		
14	M	21	14		
15	M	35	16		
16	M	19	12		
17	M	41	12		
18	F	29	16		
19	F	25	18		
20	M	21	14		
Range		19–41	12–18		
Mean		26.7	15		
Standard Deviation		6.80	2.16		

[a]Education in years; [b]Months post-injury; [c]Length of coma in days.
*Subjects 1–5 & 11–15: Group A; Subjects 6–10 & 16–20: Group B.

The CHI subjects were administered the Peabody Picture Vocabulary Test—Revised (PPVT-R) (Dunn & Dunn, 1981) and the verbal ability and reasoning clusters from the Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1977). For the PPVT-R, standard scores and percentile ranks were reported. For the Woodcock-Johnson, cluster scores and age scores were recorded for both clusters. These data as well as specific cognitive level are presented in Table 2.

As the experimental task was an exemplar recognition task involving the reading of words and short phrases, all CHI subjects were required to achieve at least 70% accuracy on a reading screening test. The screening

TABLE 2. CLINICAL TEST DATA

	PPVT[a]		W-J[b] Verbal Ability		W-J[b] Reasoning		
Subjects	SS	PERCENTILE	CLUSTER	AGE	CLUSTER	AGE	*Level*[c]
1*	109	72	566	30	504	11.1	8
2	110	74	566	30	533	26	8
3	85	16	562	27	489	7.9	7
4	96	40	563	28	502	10.8	7
5	100	50	578	34	495	9.0	8
6	67	3	455	6.2	461	5.0	7
7	115	84	606	34	468	5.6	8
8	100	50	577	34	489	7.9	8
9	85	16	541	17.7	503	10.10	8
10	97	42	505	10.9	483	6.11	7

[a]Peabody Picture Vocabulary Test—Revised; [b]Woodcock-Johnson Psycho-Educational Battery; [c]Level of functioning on the Ranchos Los Amigos Scale.
*Subjects 1–5: Group A; Subjects 6–10: Group B.

test was composed of 10 sentence completions with two multiple choice answers.

Materials and Procedure

The 10 CHI and 10 neurologically intact subjects were randomly assigned to one of two groups. Each of the A and B groups was administered a different set of eight goal-derived categories (Table 3) presented visually in a booklet. Each page in the booklet lists one goal-derived category followed by 12 items, six of which were members of the category. These six exemplars consisted of two highly typical, two moderately typical, and two atypical members. Typicality was determined by goal-derived category norms established by Hough (1988) with normal middle-aged adults. Specifically, on a 7-point rating scale, highly typical exemplars had ratings between 1.0 and 2.0, moderately typical exemplars had ratings between 2.50 and 3.50, and atypical exemplars had ratings between 4.0 and 5.0. The remaining 6 items were nonmembers, which were clearly not members of the specified category. Subjects were asked to circle the items that were exemplars of the category label presented at the top of the booklet page. There was no pre-set time limit for verifying category members.

TABLE 3. GOAL-DERIVED CATEGORY LABELS

Group A
Things that can be folded
Things to sell at a garage sale
Things that have a smell
Things to take on a camping trip
Things that can fall on your head
Things that can roll
Things that can be used for hitting
Things that are poisonous
Group B
Things that can float
Things to take on a vacation
Things to inventory at a store
Things to take on a picnic
Things that can be walked upon
Things to take from one's house during a fire
Things to use to prop open doors
Things that can be leaned upon

RESULTS

As there were no significant differences between the CHI and non-brain-damaged Groups A and B on accuracy of identification, data for the A and B groups were combined for further analyses. Mean accuracy performance on the identification of the high, mid, and atypical exemplars for the CHI and non-brain-damaged adults is presented in Figure 1. Mean scores are at the top of each column with standard deviations below the means in parentheses. A two-way analysis of variance (ANOVA) with one between (group) subject variable and one repeated measure (category member typicality) was conducted on the accuracy data for identifying the goal-derived category items. The ANOVA results revealed no significant differences between the CHI and normal groups overall ($p > .10$) and there was no significant interaction between group and category member typicality ($p > .10$). There was, however, a significant main effect for category member [$F(2,36) = 4.06$; $p < .05$], reflecting both groups' sensitivity to typicality of the exemplars, as displayed in Figure 1. Specifically, both groups displayed reduced accuracy of identification for the mid and atypical exemplars.

Nonmember accuracy of identification data for the CHI and non-brain-damaged subjects are presented in Table 4. These data were analyzed separately because the number of nonmember items was different from

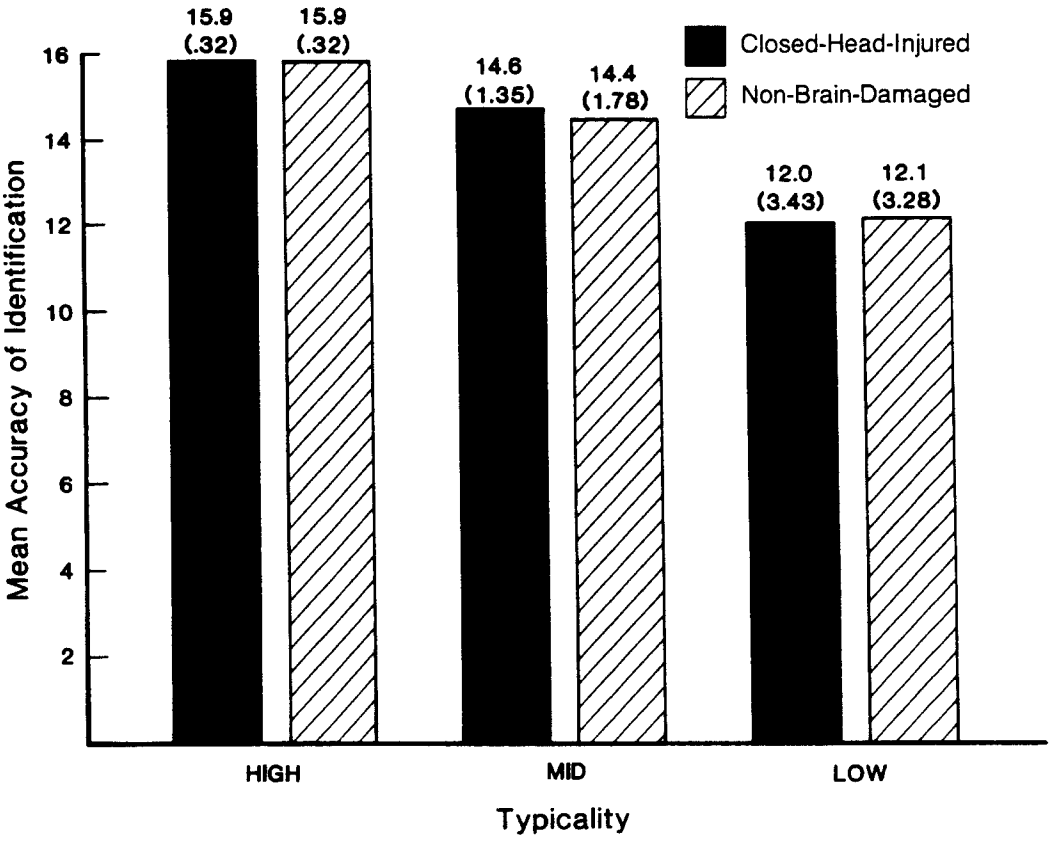

Figure 1. Mean accuracy performance for the CHI and non-brain-damaged groups on exemplar verification.

the number of high, mid, and atypical member items' verification. An independent *t* test on the nonmember data revealed no significant difference between the two groups ($p > .10$). Thus, typicality level of the exemplars as well as out-of-set identifications revealed no significant differences between the two groups.

DISCUSSION

The results indicate that, as a group, the CHI subjects were able to verify the category membership of goal-derived category exemplars as effectively as the neurologically intact adults. The typicality or representativeness of the exemplars did not adversely affect performance of the CHI subjects. In fact, these individuals were as sensitive as the non-brain-damaged subjects to the graded structure continuum of the category

TABLE 4. NONMEMBER ACCURACY DATA

Subjects		*Group* CHI	*Group* NBD
1*		48	47
2		48	47
3		47	48
4		46	47
5		46	45
6		45	48
7		45	48
8		48	48
9		46	48
10		47	48
	Mean	46.6	47.4
	Standard Deviation	1.17	.97

*Subjects 1–5: Group A; Subjects 6–10: Group B.
Note: Score is out of a possible 48 per subject.

members. Hough, DiFilippo, Pierce, and May (1990) found that although CHI subjects produced a significantly lower percentage of accurate goal-derived category responses than normal adults on an exemplar generation task, they were able to retrieve in-set category exemplars from relatively normal aspects of category structure.

The present observations may have been influenced by an interaction of several variables, including post-injury time of the closed-head-injured subjects, level of subject functioning, and the nature of goal-derived categories. As mentioned previously and observed in Table 1, the CHI subjects in the current investigation displayed chronic deficits, having a mean post-injury time of 57.2 months and a range beginning at 18 months. Furthermore, as was reported in Table 2, our CHI subjects were high level individuals, functioning at Level 7 or 8 on the Ranchos Los Amigos Scale (Hagen & Malkmus, 1979).

The most influential variable appears to be the unique nature and construction of goal-derived categories. These categories are instrumental to achieving a specific goal, each exemplar being a dimension relevant to the goal. Goal-derived category construction involves a generate-test process in which individuals rely on their previous knowledge and experience to establish dimensions relevant to the goal of a particular category. Individuals may utilize the associative structure of related well-established categories, such as common categories, to compare possible instances of a less established category. The schematic structure and divergent nature of goal-derived categories may account for the present results.

In summary, high functioning closed head injured adults are able to recognize and categorize goal-derived category members similarly to normal subjects. This occurs despite results reported by Hough et al. (1990) that closed-head-injured subjects generated significantly more out-of-set responses than non-brain-damaged adults for the same set of goal-derived categories. The present findings, in conjunction with the Hough et al. (1990) results, continue to support the hypothesis that difficulties in word finding for CHI adults may occur in the presence of normal goal-derived category structure. These findings have implications for the focus and level of cognitive process and language treatment considered with long term, high level CHI individuals.

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