

0.49) is barely significant at $P = .05$ level (on the basis of the t test) but it is considerably attenuated in comparison with corresponding differences observed with faster rates of presentation. High-priority lists 2 and 8 show no evidence of retrograde amnesia in free recall at the rate of 2 seconds per word.

The most promising explanation of retrograde amnesia in free recall appears to be some version of the consolidation hypothesis. The asymmetry of the amnesic effects of the high-priority event as well as the apparent rate-sensitivity of the phenomenon rule out a number of otherwise plausible interpretations. My data suggest that the initial registration or the encoding phase of the act of remembering sometimes extends beyond the temporal interval during which the event to be remembered is physically present in the subject's field of view. It is this processing, after exposure, of rapidly occurring events that seems to be interfered with by the supervention of another event which is afforded high-priority treatment by the system.

Consolidation-like processes have frequently been postulated in theoretical accounts of human memory. Peterson (5), for instance, assumed that consolidation of one component

of the memory trace accounted for the paradoxical observation that a verbal item presented twice in the input series was recalled best when it was partially forgotten before its second presentation.

The method described here may have some value in probing the consolidation process. It may also lead to other insights into the nature of memory.

ENDEL TULVING

Department of Psychology,
University of Toronto, Canada

References and Notes

1. S. E. Glickman, *Psychol. Bull.* **58**, 218 (1961); L. Weiskrantz, in *Amnesia*, C. W. M. Whitty and O. L. Zangwill, Eds. (Butterworths, London, 1966), p. 1; A. Weissman, *Intern. Rev. Neurobiol.* **10**, 167 (1967).
2. J. L. McGaugh, *Science* **153**, 1351 (1966); D. J. Lewis and B. A. Maher, *Psychol. Rev.* **72**, 225 (1965); E. E. Coons and N. E. Miller, *J. Comp. Physiol. Psychol.* **53**, 524 (1960); P. H. Schiller and S. L. Chorover, *Neuropsychol.* **5**, 155 (1967).
3. It affords relatively precise control over the duration of events to be remembered and the amnesic events and their temporal separation, and it includes a comparison between retrograde and anterograde effects of amnesic events.
4. E. Tulving, in *Verbal Behavior and General Behavior Theory*, T. R. Dixon and D. L. Horton, Eds. (Prentice-Hall, Englewood Cliffs, N.J., 1968), p. 2.
5. L. R. Peterson, *Psychol. Rev.* **73**, 193 (1966).
6. Supported by NRC grant APA-39 and NSF grant GB-3710. I thank L. King for experimental assistance. A paper describing my method and data was delivered at the 9th Annual Meeting of the Psychonomic Society, 2 November 1968, in St. Louis, Mo.

2 December 1968

Linguistic Structure and Transposition

Abstract. *Transfer of a learned discrimination along the size dimension was studied in groups of American and African tribal children. The language spoken by the African children contains an asymmetry in the expression of size comparisons that is not present in English. Contrary to theories of linguistic mediation of choice behavior, transfer choices were not related to the differing linguistic patterns; however, initial choices and post-test descriptions of choices were so related.*

The most familiar version of the hypothesis that performance of non-verbal tasks is mediated by linguistic competence (1) is that thought is formed and channeled by the semantic and syntactic capacities of one's language. Despite difficulties, certain formulations (2) of this hypothesis have been subjected to experimental evaluation (3, 4).

The study of transposition of discrimination in children has often been used for analyzing presumed linguistic mediation (5). In the transposition experiment, the task is to discriminate between related stimuli at two points on the dimension defined by that relation. In the United States it is generally

found that older children transpose across a wider range of stimuli than younger children do (5, 6). This is often but not always (7) taken as evidence that linguistic competence favors certain forms of choice behavior.

Our study is based on an asymmetry in verbal comparison discovered in the course of an investigation of the relation between culture and learning (8). The Kpelle of north-central Liberia habitually put the member with the higher value first in the comparison of two objects. This same asymmetry is not present in standard American English. For example, the Kpelle normally would say, "John's house is big past (bigger than) Flumo's house," but only

rarely would say "Flumo's house is small past (smaller than) John's house." In American English, both comparisons occur with equal frequency.

The presence in the Kpelle language of an asymmetry not found in English suggested a study of Kpelle and American children learning to transpose a size comparison from one pair of stimuli to another similar pair. Strong forms of the theories of linguistic mediation lead to the hypothesis that rate of learning and amount of transposition would be biased in the direction predicted from our observations of the linguistic asymmetry in making size comparisons.

The African subjects were 160 Kpelle children, divided into three groups as follows: group 1, illiterates 4 to 5 years old; group 2, illiterates 6 to 8 years old; and group 3, first-graders 6 to 8 years old who attended government schools. Groups 1 and 2 spoke little or no English and had not attended any form of Western school. The children in group 3 were functionally illiterate and spoke only a limited amount of pidgin English but had been exposed to the school environment for at least 6 months. The American subjects (group 4) were 72 nursery school children, 3 to 5 years old (average age of 4 years, 2 months).

The stimulus materials consisted of ten opaque white plexiglass squares. The smallest square had an area of 12.2 cm², and the area of each successive square was larger than that of its neighbor in the ratio of 1.4:1.

The experimenter and subject sat across a table from each other with a small barrier between them so that the experimenter had a place to write responses and arrange stimuli beyond the view of the subject. The subject was read the following instructions (in his native language): "I will show you two things. Each time I show you these things you must tell me which one I am thinking of. If you are correct, I will say yes. If you are wrong, I will say no. Try to be correct every time." After each correct response, the experimenter said, "Yes, very good" or some equivalent words of encouragement. After each incorrect response the subject was told, "No."

Training was carried out on the middle blocks in the series, blocks 5 and 6. For half of the subjects the smaller block was always correct and for the remainder the larger block was correct. Trials were presented until a criterion of nine consecutive correct

responses was attained at which point a series of ten test trials was administered without any pause in the procedure.

During testing each of the major groups was subdivided according to the pair of blocks presented for testing. For subjects trained on the larger training block 6, three independent groups were formed by testing on blocks 6 and 7, 7 and 8, or 9 and 10. Similarly three groups were formed for each group trained on the smaller block 5. These groups were tested on blocks 4 and 5, 3 and 4, or 1 and 2. These manipulations are referred to as transposition up (train on 6, test on 6-7, 7-8 or 9-10) or transposition down (train on 5, test on 4-5, 3-4 or 1-2) and the testing pairs are described as near, medium and far tests, depending on their physical distance from the training stimuli.

The training series was balanced so that the larger and smaller blocks were represented equally often in haphazard order on the left and right sides in every block of ten trials. Two different testing orders were given within each subgroup.

After testing was completed, the last pair of test blocks remained on the table and the subject was asked, "Why did you choose this one?" (pointing to the block chosen last). Any response referring to size was scored as a relevant verbalization.

At the start of training, the African children exhibited a bias on the first trial in favor of guessing that the larger of the two blocks was correct: 68.5 percent chose the larger block ($\chi^2 = 15.9$; d.f. = 2; $P < .005$). There was no significant trend toward a stronger bias in the younger illiterate groups. The American children exhibited no such bias ($\chi^2 = 1.1$; d.f. = 1; $P > .10$). In terms of total trials to reach the criterion, the only significant trend was for the older African children to learn more quickly than the younger ones ($F = 5.94$; d.f. = 2, 198; $P < .01$). There were no significant differences among the American subgroups.

The purest measure of transposition is obtained on the first test trial after the training series is complete, because this trial is uncontaminated by any effects of nonreinforced presentations of the test blocks. Among the African children the only variable significantly affecting choice performance was again the differences among the three populations ($\chi^2 = 6.2$; d.f. = 2; $P < .025$). The proportions of transposition re-

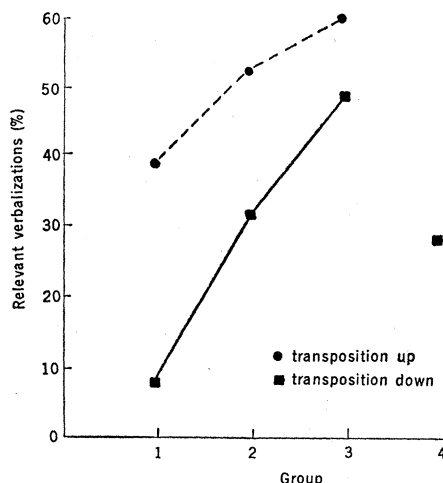


Fig. 1. Percentages of relevant descriptions for choices in transition responses. Group 1, African illiterates, 4 to 5 years old; group 2, African illiterates 6 to 8 years old; group 3, African first-graders, 6 to 8 years old; group 4, American nursery school children, 3 to 5 years old.

sponses for the three groups were 91.6, 83.3, and 76.3 for the first-graders, illiterates 6 to 8 years old, and illiterates 4 to 5 years old, respectively. The difference among proportions for near, medium and far tests (86.1, 84.7, 80.6) and up and down tests (86.1 and 80.6) fell far short of significance (in each case, $\chi^2 < 1.0$). For the American children neither the near, medium, far (91.6, 83.3, 79.1) nor the up and down effects (83.3, 86.1) were significant (in each case $\chi^2 < 1.0$). Exactly the same results were obtained from an analysis of the total series of ten test trials.

When the percentage of African children who were able to give a relevant description of their choices is considered, the linguistic asymmetry once again appears (Fig. 1). Overall, the percentage of relevant verbalizations was greater for those trained to choose the larger stimulus (50 percent compared to 28.7 percent; $\chi^2 = 9.2$; d.f. = 1; $P < .01$). As Fig. 1 indicates, there was a trend for the difference between the up and down conditions to decrease for the older groups, tending toward equality with the first graders. The American children manifested perfect symmetry in their verbalizations—both the up and down groups made 27.7 percent relevant responses.

The results of this study fail to support the notion that an implicit verbal response mediates children's choice behavior on test trials in the transposition experiment. Some weaker form of the linguistic mediation hypotheses would appear to be called for (9). The Kpelle

linguistic asymmetry is manifested under only two conditions—on the initial choice, when the child has no information on which to make a choice, and after testing, when he is asked to justify his choices. The first manifestation of the asymmetry is compatible with those interpretations of the relation between language and thought which assign to language an important function in determining the relative availability of different categories (3); given a completely ambiguous choice, the more readily available concept determines choice. The lack of a bias operating on the test trials, combined with a bias on the verbalization test, suggests that a distinction must be made between the role of language in mediating choice and its role in communicating the rationale underlying the choice. Procedures which seek to tap "mediating responses" by tests for verbalization given after the learning experience may in fact be assessing the child's ability to represent the outcome of some action to himself and others at a later time. By analogy with the work of Brown and others (10) we might hypothesize that the more frequent use of the phrase "larger than" in Kpelle makes it more accessible to memory at the time of the verbalization tests.

MICHAEL COLE

University of California, Irvine

JOHN GAY

Cuttington College, Liberia

JOSEPH GLICK

University of Minnesota, Minneapolis

DONALD SHARP

University of California, Irvine

References and Notes

1. B. L. Whorf, *Language, Thought and Reality: Selected Writings of Benjamin Lee Whorf*, J. B. Carroll, Ed. (Wiley, New York, 1956).
2. J. A. Fishman, *Behav. Sci.* 5, 323 (1960).
3. R. W. Brown and E. Lenneberg, *J. Abnorm. Soc. Psychol.* 49, 454 (1954).
4. J. B. Carroll and J. B. Casagrande, in *Readings in Social Psychology*, E. E. Maccoby, T. M. Newcomb, E. L. Hartley, (Holt, Rinehart, & Winston, New York, 1958).
5. M. K. Kuenne, *J. Exp. Psychol.* 36, 471 (1946).
6. H. Reese, *Psychol. Bull.* 59, 502 (1962).
7. M. Zeiler, in *Advances in Child Development and Behavior*, L. P. Lipsitt and C. C. Spiker, Eds. (Wiley, New York, 1967).
8. J. Gay and M. Cole, *The New Mathematics and an Old Culture* (Holt, Rinehart, & Winston, New York, 1967).
9. It is possible to treat mediation as an intervening variable and to maintain that the present operations fail to manipulate mediation. This position would clearly be unaffected by the present results.
10. R. W. Brown, in *A Study of Thinking*, J. S. Bruner, J. J. Goodnow, G. A. Austin, Eds. (Wiley, New York, 1956), pp. 247-312; D. D. Lantz and V. Steffle, *J. Abnorm. Soc. Psychol.* 50, (1954).
11. Supported by grant NSF G1221 to M.C. We thank P. Ricks and B. Hansen for assisting in collection of the data.

25 September 1968