Stimulus Saliency in the Sorting Behavior of Aphasic Adults

Sandra B. Milton
Casa Colina Hospital for Rehabilitative Medicine, Pomona, California

Robert T. Wertz
Veterans Administration Medical Center, Martinez, California

Richard C. Katz
Veterans Administration Out Patient Clinic, Los Angeles, California

Carol A. Prutting
University of California--Santa Barbara, Santa Barbara, California

A variety of ill defined concepts—learning characteristics, cognitive style, stimulus saliency, etc.--have been used to explain aphasic patients' performance on appraisal and treatment tasks (Carson, Carson, and Tikofsky, 1968; Darley, 1976; Haaland, 1979; Horner and LaPointe, 1979; Faber and Aten, 1979; Kaplan, 1980). Whether these concepts differ between normal and aphasic adults is not clear. If they do, the difference may be (a) diagnostic (indicative of brain injury); (b) preferential (some individuals elect color and others respond to shape); or (c) inconsequential (the differences do not make a difference).

A popular way of determining whether conceptual differences exist between aphasic and normal adults is to employ a sorting task that manipulates several stimulus dimensions. While a number of these exercises have been reported (Tikofsky and Reynolds, 1962, 1963; Milner, 1963), to our knowledge, no assessment of stimulus saliency in aphasic patients had been reported that controlled the competitive availability of perceptual and linguistic relationships among the stimuli in the sorting task. Our intent is to fill this apparent void in the literature.

Several variables may influence an aphasic adult's sorting performance. The patient may not recognize the semantic attributes of the stimuli used, or the patient may attend to perceptual rather than linguistic stimulus dimensions. In fact, one might predict that perceptual dimensions would be most salient for aphasic adults, because damage is typically in the speech and language dominant left hemisphere.

Exploration of perceptual versus linguistic salience of stimuli may be more than just interesting. Stimulus salience may influence treatment. For example, a common clinical task is semantic classification. Pictorial stimuli are used, and the patient is instructed to group pictures into appropriate semantic-functional categories such as "things you eat" and "sports equipment." The patient who attends to perceptual dimensions rather than to semantic-functional dimensions may place a basketball and an orange within the same category. What the clinician considers a linguistic task might be, for the patient, a perceptual (color or shape) task. Thus, on a task that permits a variety of solutions, the clinician may select one solution as correct and the aphasic patient may select another. Because clinicians usually score an aphasic patient's performance rather than the other way around, the patient is judged "wrong" but does not know whether or why.

We designed an investigation of the potential dilemma just described. Answers were sought to three questions: (1) Do aphasic patients differ from normal adults in their performance on sorting tasks that permit perceptual or semantic-functional classification? (2) What are the relationships between an aphasic patient's age, education, nonverbal intelligence, months postonset, language severity and performance on perceptual and semantic-functional sorting tasks? (3) Are there differences in sorting behavior when the task permits constrained or free classification compared to tasks that employ cued, categorical classifications?

METHOD

A matched-subject design involving 15 right-handed adult aphasic patients and 15 neurologically normal adults was used. Subject selection criteria for the aphasic group included evidence of a completed single left hemisphere cerebrovascular accident, the presence of aphasia, 70 years of age or younger, and premorbid literacy in English. Subject descriptive data are shown in Table 1.

Table 1. Descriptive information for the normal and aphasic groups.

MEASURE	GROUP					
	Normal (N = 15)			Aphasic (N = 15)		
	Mean	Range	S.D.	Mean	Range	S.D.
Age (In Years)	60.3	49-70	6.1	60.5	47-70	6.5
Education (In Years)	13.3	9-19	3.0	12.8	8-19	3.3
Months Post-Onset	-	-	-	50.1	2-226	66.8

The aphasic group was composed of nine males and six females. Fourteen aphasic patients were living at home, and one was an inpatient in a rehabilitation facility. Eleven patients exhibited residual right hemiparesis. No significant differences ($p > 0.05$) for age or education were found between the aphasic and control groups.

The Porch Index of Communicative Ability (PICA) (Porch, 1967) and portions of the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1972) were administered to evaluate language severity and type of aphasia in the aphasic group. Both groups received the Coloured Progressive Matrices (Raven, 1946) to estimate "nonverbal intelligence." Table 2 shows that the aphasic group obtained a mean overall PICA performance at the 54th percentile with a range from the 30th to 81st percentile. Eleven aphasic patients were classified as demonstrating nonfluent aphasia according to guidelines provided by Goodglass, Quadfasel, and Timberlake (1964), and four were classified as demonstrating fluent aphasia. Performance on the BDAE subdivided the sample into eleven Broca's, one Wernicke's, one Transcortical Sensory, and two unclassifiable patients. Mean performance by the aphasic group on the Coloured Progressive Matrices was 22.9. This was significantly ($p < 0.001$) lower than the 30.0 mean performance of the normal group.

Table 2. Performance for each group on the diagnostic measures.

MEASURE	GROUP					
	Normal (N = 15)			Aphasic (N = 15)		
	Mean	Range	S.D.	Mean	Range	S.D.
Coloured Progressive Matrices	30.0	25-35	3.2	22.9	11-36	8.5
PICA Overall Percentile	-	-	-	54th	30-81	12.9

Two sorting tasks, the Muma Assessment Program (MAP) (Muma and Muma, 1978) Iconic/Symbolic Processing Subtest and a perceptual/semantic-functional free classification task developed for this investigation were administered to all subjects. Both tasks control stimulus dimensions systematically, and both permit color, shape, and semantic-functional classifications on each of the 18 trials in each task.

Figure 1 shows three items used on one trial on the MAP. Each subject was instructed to choose the two pictures that best go together. An iconic response would be a selection on the basis of color or shape. A symbolic response would be a selection on the basis of the semantic-functional relationship. In Figure 1 are drawings of a clock, banana, and an orange. The color pair, clock and banana, are both yellow. The shape pair, round clock and round orange, have a similar visual configuration. The semantic-functional pair, an orange and a banana, share the common relationship of fruit you peel.

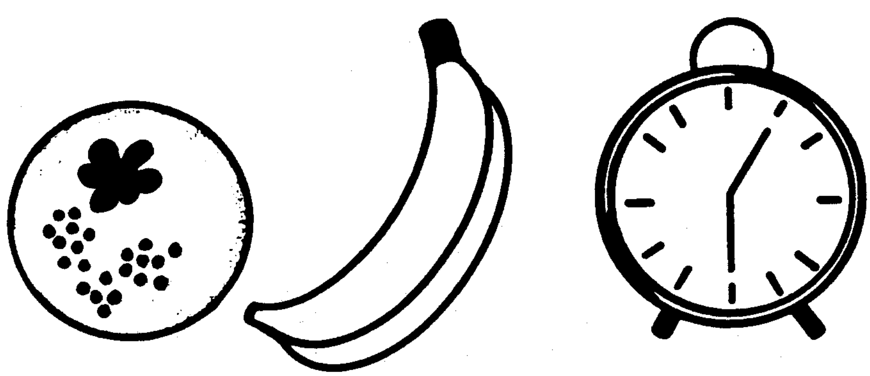

Figure 1. Stimulus card from the MAP iconic/symbolic processing subtest representing three dimensions; color (yellow clock and yellow banana), shape (round clock and round orange), and function (banana and orange are fruit you peel). (After Muma and Muma, 1978.)

The perceptual/semantic-functional free classification task was designed as a second sorting measure to avoid certain problems in the MAP. Differences between this task and the MAP are; (a) stimuli are more appropriate for adults (the MAP stimuli were developed for use with young children), (b) there are four pictures in each response matrix (compared with three in the MAP) to reduce chance classifications, and (c) a free classification format is used, which we presume is more difficult than the MAP constrained classification (i.e., free classification decreases the opportunity for chance responding by not imposing quantity restrictions; e.g., "pick two," in response choices).

Figure 2 shows the stimuli in one trial of the perceptual/semantic-functional free classification task. As in the MAP, the three dimensions are color (lemon and bag), shape (football and lemon), and semantic-functional (football and tennis racket).

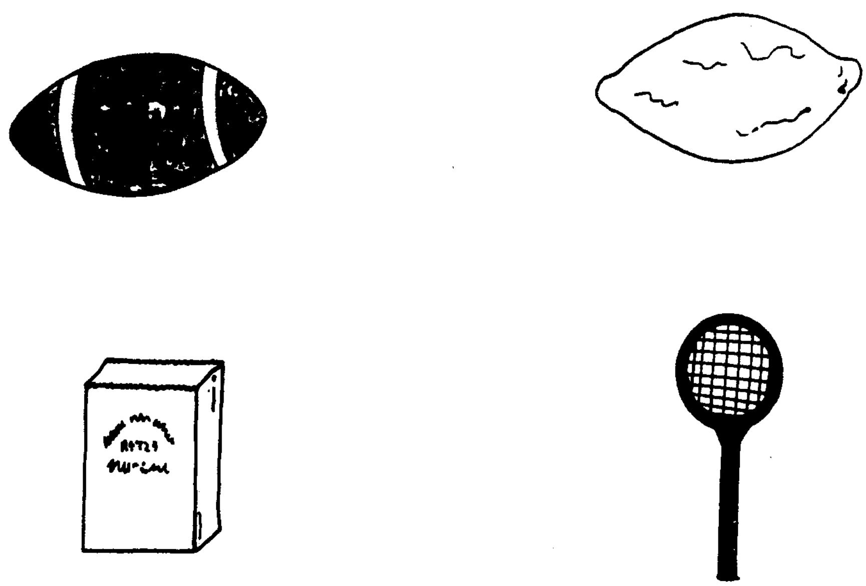

Figure 2. Stimulus card from the perceptual/semantic functional free classification task representing three dimensions; color (yellow lemon and yellow bag), shape (lemon and football), and function (football and tennis racket).

A post-test requiring cued, categorical sorting was presented to all subjects following completion of the two sorting tasks. The purpose of the post-testing was to determine whether categorical cueing increased the saliency of semantic-functional relationships. To answer this question, the stimulus set for each trial in each task was presented, one at a time. The subject was requested to "point to the pictures which go together best because of function--that are used together or in about the same way." A three by five inch card depicting examples of semantic-functional groupings was presented simultaneously, in order to enhance the subject's comprehension of the task required and to minimize verbal instructions.

RESULTS

Table 3 shows that sorting performance on the MAP by the aphasic group differed significantly ($p < 0.001$) from that of the normal group. Aphasic subjects made significantly fewer semantic-functional groupings and significantly more perceptual groupings than normal subjects. Variability within the aphasic group was greater than within the normal group. Individual data indicated that two aphasic patients were iconically-oriented (sorted by perceptual dimensions), nine were symbolically-oriented (sorted 11 or more of 18 trials by the semantic-functional dimension), and four did not exhibit a strong response pattern. All 15 normal subjects were symbolically-oriented.

Table 3. Group sorting performance on the MAP iconic/symbolic processing subtest.

SORTING DIMENSION	GROUPS					
	Normal (N = 15)			Aphasic (N = 15)		
	Mean	Range	S.D.	Mean	Range	S.D.
Semantic Functional	17.20	15–18	0.88	11.17	2–18	4.98
Perceptual (Color or Shape)	0.40	0–2	0.63	6.13	0–16	5.02
Other	0.27	0–3	0.80	0.33	0–2	0.72

Similar results were obtained on the perceptual/semantic functional free classification task. Table 4 shows that the aphasic group made significantly ($p < 0.001$) fewer semantic-functional groupings and significantly more perceptual groupings than the normal group. Again, variability within the aphasic group was greater than within the normal group. Using MAP criteria, three aphasic patients were iconically-oriented, seven were symbolically-oriented, and five did not demonstrate a strong response pattern. All 15 normal subjects were symbolically-oriented. The answer to our first question, then, was "yes," aphasic patients do differ from normal adults in their performance on sorting tasks that permit either perceptual or semantic-functional classification.

Our search for an explanation for the sorting behavior of aphasic subjects and the variability among subjects in the aphasic group did yield an answer. No significant correlations ($p > 0.05$) were found between sorting performance and age, education, months postonset of aphasia, language severity measured by the PICA, or nonverbal intelligence measured by the Coloured Progressive Matrices. In addition, type of aphasia--fluent or nonfluent--offered no explanation. Thus, the answer to our second question was "no"--sorting behavior in aphasic patients could not be explained by the variables we examined.

Table 4. Group sorting performance on the perceptual/semantic-functional free classification task.

SORTING DIMENSION	GROUPS					
	Normal (N = 15)			Aphasic (N = 15)		
	Mean	Range	S.D.	Mean	Range	S.D.
Semantic Functional	16.13	11-18	1.82	9.63	1.5-17	5.45
Perceptual (Color or Shape)	1.10	0-5.5	1.75	5.80	0-14.5	5.21
Other	0.20	0-1	0.41	1.80	0-6	2.04

Posttesting, using a semantic-functional categorical cue, seemed to enhance the saliency of the linguistic dimension in our stimuli for most members of the aphasic group. Table 5 shows that the aphasic group made significantly ($p < 0.001$) more semantic-functional groupings on the MAP in the cued categorical condition. Thirteen of 15 aphasic patients made from one to 14 more semantic-functional groupings when cued. All but one of the 15 aphasic patients demonstrated symbolic orientation.

Table 5. Constrained versus cued categorical classification mean results on the MAP iconic/symbolic processing subtest.

GROUP	CONDITION Constrained	Cued Categorical	CHANGE
Normal	17.2	17.6	+ 0.4
Aphasic	11.2	15.3	+ 4.2

Table 6 shows that a similar, significant ($p < 0.001$) move toward the linguistic dimension was made in the cued categorical condition on the perceptual/semantic-functional free classification task. Twelve of 15 aphasic patients made from one to nine more semantic-functional groupings when cued. All but two of the 15 aphasic patients demonstrated symbolic orientation. In the normal group, no significant ($p > 0.05$) changes in the cued categorical condition were observed on either task. However, there was little opportunity for normal subjects to increase their semantic-functional groupings, because most grouped that way in both the test and posttest conditions. The answer to our third question is "yes" and "no"--aphasic patients perform differently when a cue is added, but normals do not.

Table 6. Free classification versus cued categorical classification mean results on the perceptual/semantic-functional free classification task.

GROUP	CONDITION		CHANGE
	Free Classification	Cued Categorical	
Normal	16.1	16.8	+ 0.7
Aphasic	9.6	13.3	+ 3.7

DISCUSSION

While our results are relatively clear, an explanation for them is not. Our normal group demonstrated a stronger tendency to sort by semantic-functional dimensions than did our aphasic group. The aphasic group's sorting behavior could not be explained by the severity of aphasia or nonverbal intellectual deficit. When cued to sort by the semantic-functional dimension, aphasic patients increased the number of their semantic-functional groupings. Why all of this occurred is not obvious to us.

Several explanations for the results appear tenable. Left hemisphere damage that results in aphasia may increase the saliency of perceptual dimensions in stimuli. This could reflect a semantic-functional deficit resulting from the left hemisphere lesion or the emergence of right hemisphere perceptual dominance. However, performance by the aphasic group could not be explained by severity of aphasia, and a semantic-functional cue was sufficient to inhibit, or lessen, any right hemisphere perceptual influence. Thus, neither explanation is a reliable reason for our results.

It is possible that an aphasic individual's style of performance, impulsive or reflective, affects sorting performance. Impulsivity has been related to a decreased ability to inhibit rapid responses, a commitment to a problem solution before considering potential alternatives, and a reduction in sustained attention to the task at hand (Luria, 1966; Muma, 1978). Reflectivity is marked by an increased tendency to pause before deciding on a solution. A longer period of deliberation is assumed to lead to more careful evaluation of alternatives in a given situation. Luria (1966) suggested that impulsive behavior and reduced concentration occur following brain damage. Shape and color relationships may be easier to discern than semantic-functional similarity. Accordingly, an impulsive performer might display a tendency to sort by perceptual similarities and not consider alternative, potentially more appropriate possibilities. Our design did not include a measure of performance style; therefore we can only speculate on the relationship between impulsivity and sorting behavior.

Clinical implications of our results are more obvious. Aphasic patients may select a different alternative from that intended by the clinician. However, aphasic patients appear cooperative. If the clinician communicates what is intended, the patient attempts to comply. Further, the potency of perceptual saliency might be a way of focusing a patient's attention on a target stimulus. Once focused, the perceptual cues can be faded. Finally, the tendency for aphasic patients to select perceptual dimensions over semantic-functional dimensions suggests the need to control for the number of alternatives in tasks designed to emphasize a single dimension. A reasonable test or treatment task hierarchy might involve beginning with one alternative present (for example semantic-functional) and gradually adding additional alternatives as the patient demonstrates an ability to cope with ambiguity.

REFERENCES

Carson, D.H., Carson, F.E. and Tikofsky, R.S. On learning characteristics of the adult aphasic. Cortex, 4, 92-112, 1968.

Darley, F.L. Maximizing input to the aphasic patient: A review of research. In R.H. Brookshire (Ed.), Proceedings of the Conference on Clinical Aphasiology. Minneapolis, MN: BRK Publishers, 1976.

Faber, M. and Aten, J. Verbal performance in aphasic patients in response to intact and altered pictorial stimuli. In R.H. Brookshire (Ed.), Proceedings of the Conference on Clinical Aphasiology. Minneapolis, MN: BRK Publishers, 1979.

Goodglass, H. and Kaplan, E. The Assessment of Aphasia and Related Disorders. Philadelphia: Lea and Febiger, 1972.

Haaland, K.Y. The utility of an information processing approach in speech and language evaluations. In R.H. Brookshire (Ed.), Proceedings of the Conference on Clinical Aphasiology. Minneapolis, MN: BRK Publishers, 1979.

Horner, J. and LaPointe, L. Evaluation of learning potential of a severe aphasic adult through analysis of five performance variables. In R.H. Brookshire (Ed.), Proceedings of the Conference on Clinical Aphasiology. Minneapolis, MN: BRK Publishers, 1979.

Kaplan, E. Function, dysfunction, and treatment of left and right brain-damaged patients. Veterans Administration, Southwest Regional Medical Education Symposium, Anaheim, California, 1980.

Luria, A.R. Higher Cortical Functions in Man. New York: Basic Books, 1966.

Milner, B. Effects of different brain lesions on card sorting. Arch. Neurol., 9, 90-99, 1963.

Muma, J.R. Language Handbook: Concepts, Assessment, Intervention. Englewood Cliffs, N.J.: Prentice Hall, Inc., 1978.

Muma, J.R. and Muma, D.B. The Muma Assessment Program: Descriptive Assessment Procedures: Cognitive-Linguistic-Communicative Systems. Lubbock, TX: Natural Child Publishing Co., 1978.

Porch, B.E. Porch Index of Communicative Ability. Palo Alto, CA: Consulting Psychologists Press, Inc., 1967.

Raven, J.C. Coloured Progressive Matrices. London: H.K. Lewis and Co., 1946.

Tikofsky, R.S. and Reynolds, G.L. Further studies of nonverbal learning and aphasia. Journal of Speech and Hearing Research, 6, 329-337, 1963.

Tikofsky, R.S. and Reynolds, G.L. Preliminary study: Nonverbal learning and aphasia. Journal of Speech and Hearing Research, 5, 133-143, 1962.

DISCUSSION

Q: You report that the aphasic patients, as a group, made significantly more perceptual groupings than the normal adult subjects on both sorting tasks. Perhaps our diagnostic tests, such as the Token Test, train the aphasic individual to focus upon color and shape stimulus dimensions.

A: That is a possibility, because most Token Tests require color and shape discrimination. Our patients came from several facilities, and we do not know whether they were given large doses of perceptual saliency through tests like Token Tests. However, we gave a pretest to both normal and aphasic group members to avoid subjects who might have difficulty recognizing perceptual and semantic-functional stimulus relationships. Five consecutive correct responses were required in a match-to-sample task using the dimensions color, shape, and semantic-function. Immediate feedback of response accuracy was provided. All control and aphasic subjects met the pretest criteria. In addition, two demonstration trials preceded administration of each sorting task. These trials were included to let the aphasic patients know the task demands and the possible dimensions--color, shape, and semantic-function--on each sorting trial.

Q: Did you compute a correlation only between the PICA Overall percentile and sorting performance, or did you look at relationships between PICA modality scores and sorting performance?

A: Correlations were computed between all PICA scores--Overall and modality scores--and sorting performance. None was significant.

Q: Did you look at the pattern of performance across trials on the sorting tasks?

A: Not formally, because the data did not indicate the effort would be worthwhile. We scored each response on the sorting tasks with the PICA multidimensional system. We thought a dimension other than accuracy might tell us something, and we thought the patient's responses across trials might be informative. Neither were. Only one patient stood out. She took twenty minutes to complete eight trials on one sorting task, because she puzzled over the stimulus dimensions. Then she moved quickly through the remaining ten trials by making all perceptual responses. Whether something "clicked" for this patient after trial eight, we do not know. Because sorting tasks are usually learning tasks, we probably need to look at performance in more dimensions than just accuracy.