MULTISENSORY STIMULATION AND ORAL FORM IDENTIFICATION IN BRAIN INJURED ADULTS

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Much theoretical interest relative to brain function has been generated by studies of intra- and intersensory differences in the recognition of specific stimuli. Some research has shown that alterations of stimulus intensity, as well as other stimulus parameters, in one modality, has significant effects on the perception of stimuli simultaneously presented through another modality (Bender, 1952; Krauthamer, 1968). In addition, the question of simultaneous multimodal vs. single modal stimulus presentation has been of interest to clinicians who deal with aphasics. In fact, Schuell, et al. (1964) emphasized the use of other sensory channels in addition to auditory stimulation in the treatment of aphasia. In a report prepared by the Subcommittee on Human Communication and Its Disorders of the NINDS (1969), Schuell stated the need for controlled research on the effects of systematically varied stimulus dimensions in the study of aphasia.

Though many clinicians use multimodal presentation of materials in aphasia therapy, experimental evidence supporting the superiority of this approach to single modal presentation has not been definitive. In a study of sensory modality and object naming in aphasia, Goodglass, Barton and Kaplan (1968) found naming abilities of aphasics to be quite uniform across the sensory modalities of vision, audition, and olfaction. No combined sensory stimulation was presented in this study, however. In another study, Aten et al. (1965) investigated the relative effectiveness of visual, auditory, and combined stimulation for vocabulary training in aphasics. No significant differences in number of words learned per training condition were found, although considerable variability within the group was noted.

In the present study, we evaluated the ability of aphasic patients to recognize various geometric shapes which were presented through three modalities: manual, visual, and intra-oral. The intra-oral modality was included because of the growing interest in oral perceptual functioning and because of the apparent neglect in the study of this modality as an avenue of sensory input. These shapes were presented unimodally and in four simultaneous multimodal combinations. The purpose of this study, therefore, was threefold: 1) To determine what relationships exist among visual, manual, and intra-oral unimodal performances by aphasics in the recognition of geometric shapes; 2) To explore whether or not simultaneous multimodal presentation of these forms has a facilitory effect on recognition; and 3) To determine if overall ability on these perceptual tasks correlate with speech and language impairment as measured by the Porch Index of Communicative Ability (PICA) (Porch, 1967).

METHOD

Fifteen aphasic, left-hemisphere damaged males, who ranged in age from 20 to 79 years with a mean of 54.2 years and who ranged in months post onset from 1 to 9 with a mean of 2.73 months, served as subjects in this study. Severity and type of aphasia were determined by evaluation of speech and language performance with the Porch Index of Communicative Ability (PICA). These subjects ranged in severity from the 20th to the 89th percentile and were classified by PICA profile as presenting either "Aphasia Without Complications," or "Aphasia with Verbal Formulation Problems," (Porch, 1967).

For the stimuli, we presented 12 geometric shapes through three modalities: manual, visual, and intra-oral. Figure 1 illustrates these twelve shapes which we adapted from a portion of the Southern California Kinesthesia and Tactile Perception Tests (Ayers, 1966).[1]

For the manual task, wooden shapes approximately 1 1/2" by 1 1/2" by 1/4" were presented to the left hand of each subject. A shield was used to prevent the subject from seeing the manually presented stimuli. Each subject responded by pointing to his choice on a placard depicting all twelve shapes.

For the visual task, each of the same twelve shapes was pictured individually on 3 x 3 cards and presented one at a time. Again, subjects responded by matching the individual card with their choice on the response placard.

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[1] Dr. Jean Ayers and Western Psychological Services, 12031 Wilshire Blvd., Los Angeles, Calif. 90025, graciously granted permission for our use of this material and reproduction of the geometric forms shown in Figure 1.

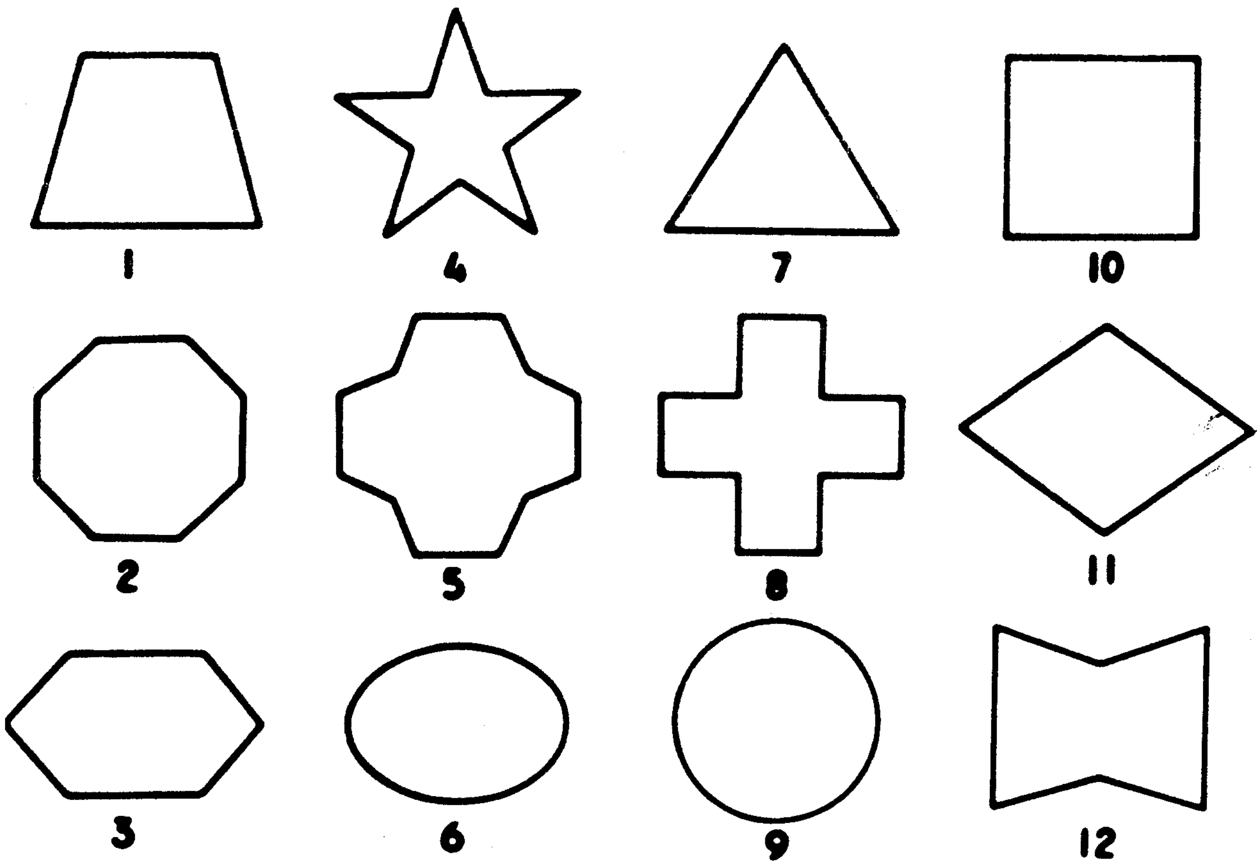

FIGURE 1. Twelve geometric shapes adapted for visual, manual, and intra-oral presentation.

For the intra-oral task, reductions of these geometric shapes (approximately 3/4" by 3/4" by 1/4") were fabricated from dental acrylic and presented to each subject following the procedures used in a previous study of oral form recognition (Williams and LaPointe, 1971). Again, subjects responded by pointing to their choice on the response placard depicting all twelve shapes.

These stimuli were presented unimodally (visual; manual; intra-oral) and in four simultaneous multimodal combinations (visual-manual; manual-oral; visual-oral; and visual-manual-oral). Order of individual shape and modality presentation was randomized, and responses were recorded for both accuracy and response time.

RESULTS AND DISCUSSION

As illustrated in Figure 2, a hierarchy of performance for the seven unimodal and multimodal subtests revealed the following order: aphasics performed most accurately with visual presentation alone, followed by visual-manual-oral, visual-manual, visual-oral, manual, manual-oral, and finally by oral. Statistically significant differences ($p < .05$) existed among the subtests represented by the different types of crosshatching on this figure.

The most conspicuous and potentially significant finding of this study was that simultaneous, multimodal presentation of geometric shapes did not facilitate recognition performance levels. None of our aphasics obtained a mean score for a multimodal subtest significantly greater than the best single modality subtest score in that combination. For example, in the performance hierarchy shown in Figure 2, it can be seen that the multimodal combinations of visual-manual-oral, visual-manual, and visual-oral fell below the mean performance level recorded for the visual modality alone.

In fact, the presentation of combinations of simultaneous multi-sensory stimuli appeared to have a distracting or dampening effect on recognition performance when compared with the single best modality in the combination. Some subjects performed poorer and apparently could not "tune-in" to their best modality, when stimuli were presented to two or all three modalities at the same time. If this finding can be generalized to other performances by aphasic patients, it has significant therapeutic implications. Our data indicate that suggestions made by other researchers on the use of multi-sensory presentation of therapy materials as a facilitory technique may be contraindicated with some aphasics. As in the study by Aten, et al. (1965), our results are interpreted as supporting individual modality preference theories, as opposed to either a universal "specific-modality" approach or a combined modality approach. Further research should explore

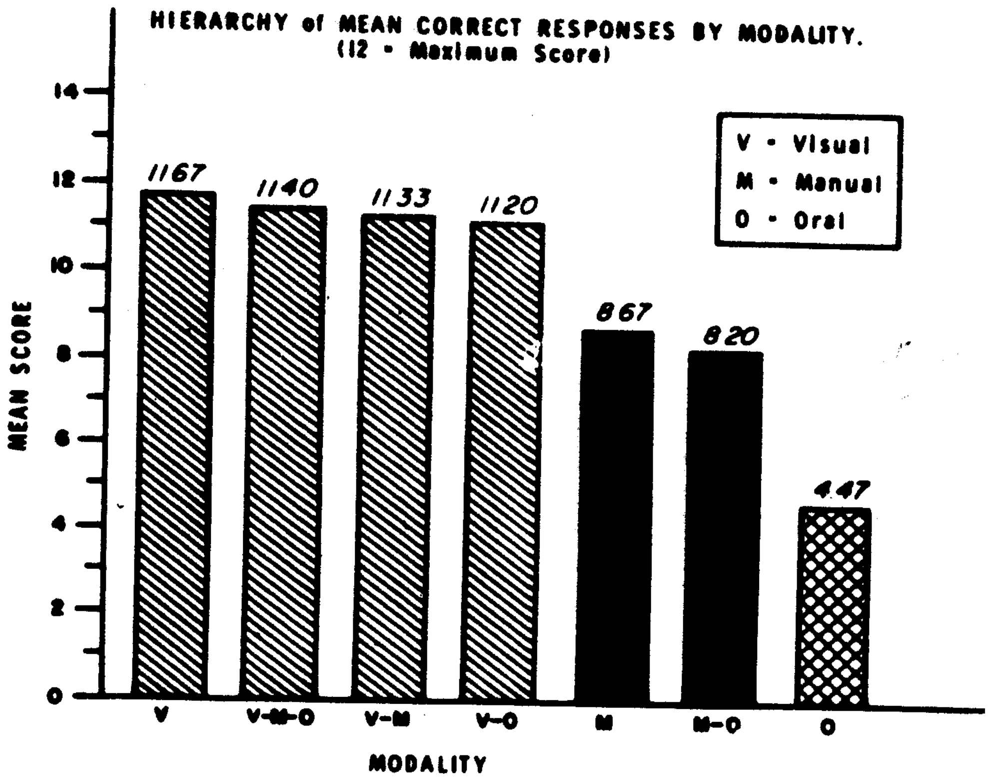

FIGURE 2. Hierarchy of mean correct responses obtained by 15 aphasic patients on the unimodal and multimodal tasks.

combinations of other sensory modalities, as well as a variety of stimulus materials.

We also recorded subjects' response time and found a significant ($p < .05$) inverse relationship to form recognition accuracy. That is, those subtests on which subjects were significantly more accurate, also reflected significantly shorter response times. This relationship of accuracy to response time was also observed in a previous study of intra-oral form recognition using normal subjects (Williams and LaPointe, 1971).

Another finding, which has appraisal and diagnostic implications, was revealed when single modality recognition scores were compared. As can be seen in Figure 3, intra-oral performance was significantly poorer ($P < .05$) than visual or manual recognition. Ten of our 15 aphasic subjects, after producing 75 to 100 percent correct responses in either the manual or visual modes, showed reduction in their ability to recognize shapes intra-orally, presenting a performance range of from 0 to 42 percent.

Normal subjects also perform better in the visual and manual modes than in the intra-oral mode, but we know from a previous study (Williams and LaPointe, 1971) that normal adults can identify about 75 percent of the forms presented intra-orally.

A recent study (Ostriecher and Hawk, 1971) has questioned the cross-modal technique of intra-oral form identification using a visually presented placard for response selection, on the grounds that aphasics have categorization, matching, and sorting impairment which might account for lowered intra-oral form identification ability. Instead, an intra-oral paired stimuli discrimination format has been suggested as more appropriate. We feel, however, that any categorization, sorting, or matching impairment in aphasics also would be reflected in their visual and/or manual performances, using a form matching technique as in our study. Though slight reductions in visual and manual performances were evident in our sample, we do not feel that categorization and sorting problems can account for the discrepancy between visual, and/or manual and oral performance which we found. When performances in all three modes are compared, we feel that the lowered intra-oral scores are a reflection of the severity of oral sensory impairment which may accompany lower facial paralysis or paresis in aphasics. However, in a study by Rosenbek (1970), no significant differences were found in the oral sensory profiles of normal subjects and aphasics, although reduced oral sensory profiles were found in subjects who presented apraxia of speech. Differences found between the performances of aphasics in our study and in that of Rosenbek may be due to variations in oral sensory stimuli, administrative procedures, or homogeneity of the subject sample.

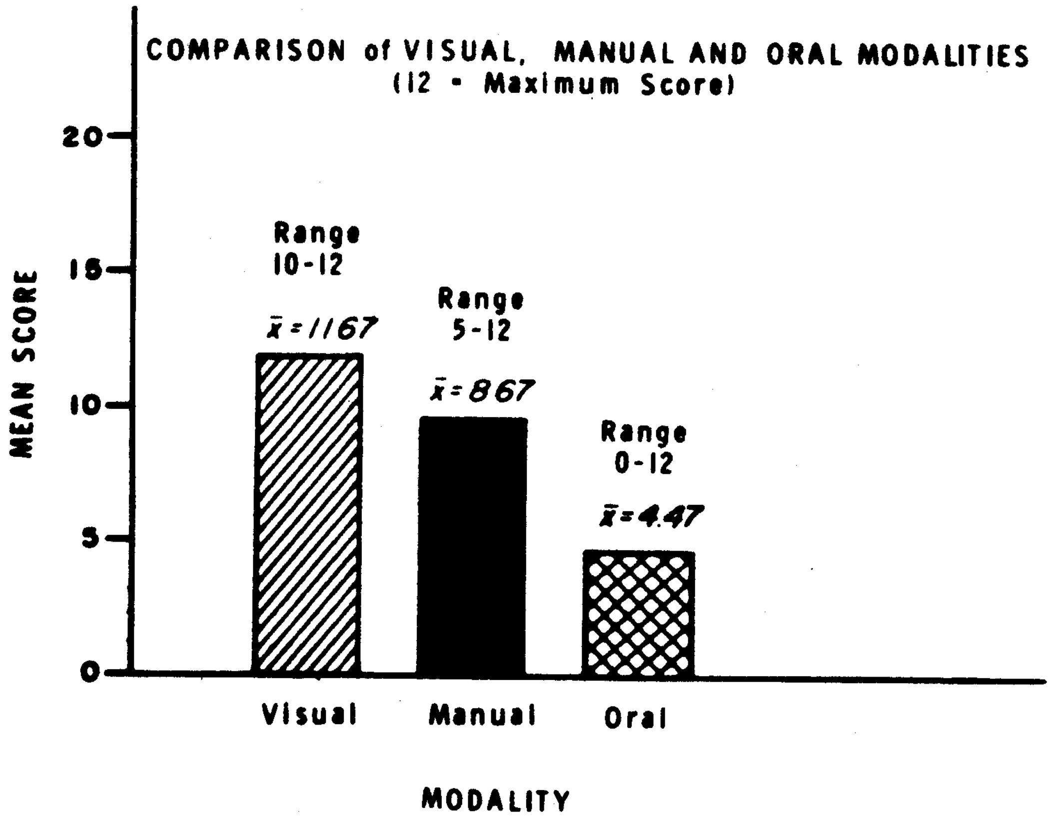

FIGURE 3. Hierarchy of mean correct responses obtained by 15 aphasic patients on the unimodal tasks.

The third purpose of this study was to explore the relationship of performance on our perceptual form identification tasks to overall speech and language impairment as measured by the PICA. Each subject's performance on the form tasks was converted to an overall percentage of correct response and compared with his PICA percentile.

As can be seen in Figure 4, there is a significant positive correlation between these two measures. A correlation coefficient of .77 was obtained which is significant at the .01 level of confidence. The high correlation between these tasks was not unexpected since many of the language skills measured by the PICA appear to be dependent upon underlying perceptual function. We were interested in which form recognition subtests contributed to the observed relationship, so we computed correlations between performance on each of the seven perceptual subtests and PICA percentiles.

Table 1 shows these correlations. As can be seen, all but two of the subtests, when treated independently, contribute to the overall positive correlation with PICA percentile.

TABLE 1. Correlations of uni- and multimodal subtests scores with PICA percentiles for 15 aphasic patients.

Comparison	r	p
V : PICA	.60	.01
*M : PICA	.37	n.s.
*O : PICA	.55	.01
V-M : PICA	.55	.01
V-O : PICA	.16	n.s.
M-O : PICA	.85	.01
V-M-O : PICA	.53	.05

* V = Visual
M = Manual
O = Oral
PICA = Porch Index of Communicative Ability

The manual subtest did not reach significance, nor did the visual-oral subtest. The point to be made from this table is that five of the seven subtests contributed relatively equally to the positive correlation between PICA percentile and form identification performance.

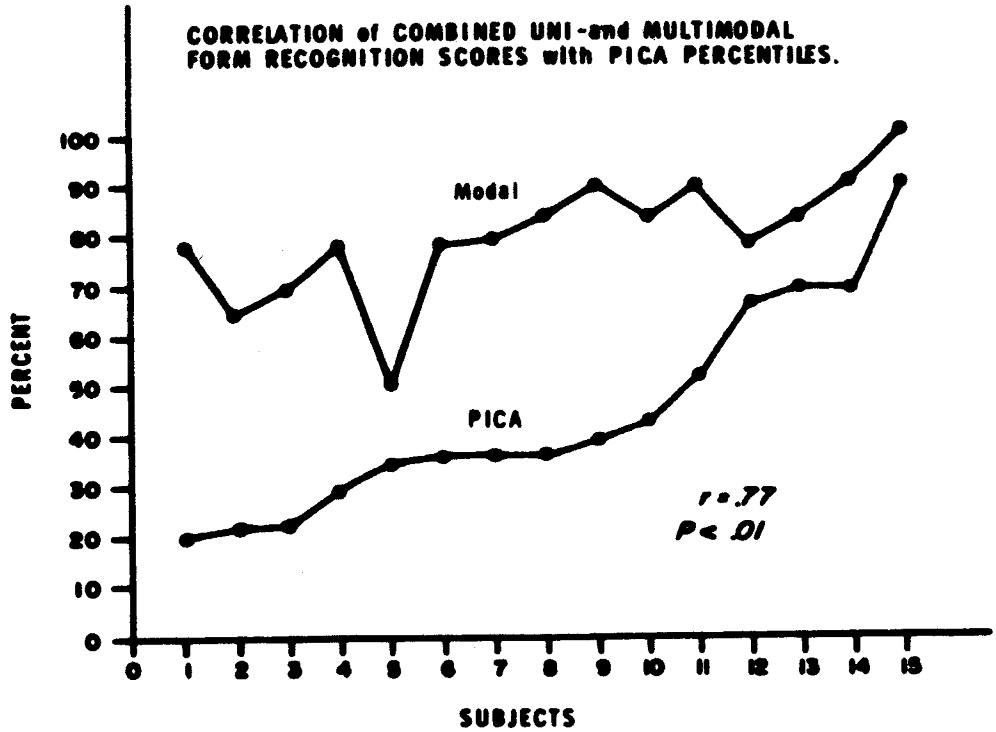

FIGURE 4. Comparison of combined uni- and multimodal form recognition scores with PICA percentiles for 15 aphasic patients.

Oral Form Identification in Left and Right Hemiplegics

We are currently collecting additional oral-form identification data on a large sample of both right and left hemiplegics. We feel this may lend additional evidence to our belief that oral-form identification may serve as a means of measuring severity of oral sensory impairment. In addition, this strategy may begin to answer some of the perplexing fundamental questions regarding the relationship of sensory impairment to severity and type of speech involvement.

In a pilot investigation, we had the opportunity to test 13 hemiplegics at an Easter Seal "stroke" camp on tasks of both visual and oral-form recognition. The results of this preliminary investigation have encouraged us to continue with a larger sample with whom we have the opportunity to collect more precise information on speech and language involvement.

Essentially, we found the following:

(1) As a group, hemiplegics did much better on visual form recognition than on the oral task (visual $\bar{x}$ = 9.6, oral $\bar{x}$ - 2.5, $p < .05$).

(2) Right hemiplegics (those with left hemisphere damage) performed significantly poorer on oral-form recognition than left hemiplegics (N = 6 right hemiplegics, $\bar{x}$ = 1.5 correct responses; N = 7 left hemiplegics, $\bar{x}$ = 3.3 correct, $p < .05$).

(3) Hemiplegics who presented evidence of speech impairment (aphasia, apraxia, dysarthria) did significantly poorer on form identification than those who presented no speech impairment (N = 8 speech impaired hemiplegics, oral form $\bar{x}$ = 1.5; N = 5 non-speech impaired hemiplegics, oral form $\bar{x}$ = 4.0, $p < .01$).

It is interesting to note that not all speech impaired hemiplegics were left-hemisphere damaged. Two subjects with right hemisphere involvement were dysarthric and presented scores of 3 and 0 on the oral form task.

These data must be viewed cautiously, but we feel encouraged to explore further oral sensory-perceptual functioning in both right and left hemiplegics.

ACKNOWLEDGMENTS

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