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ABSTRACT

This paper discusses the results of a study of 27 college students with deafness that investigated whether cognitive processes are modality dependent in individuals with deafness. The experiment included two separate parts, one composed of shape trials and the other composed of word trials. An initial stimulus was shown on a computer screen for two seconds. A two second retention period was followed by presentation of the test stimulus. Participants responded by pressing either the "Shift" key, to designate that they felt that the test stimulus included all the same shapes or shape words as the initial stimulus, or the "Option" key to designate that there was at least one different shape or shape word in the test stimulus. For initial and test stimuli in which the positions of shapes or words were the same, participants responded to the shapes more quickly when they appeared in an array than when they appeared in a linear format; however, results suggest subjects retained the word information in a sequential, sentence-like format. Strong readers performed better than weak readers on word stimuli. The study indicates that dual coding theory predictions hold for individuals with deafness. (CR)

Deaf College Students' Representation of Image and Verbal Information

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Deaf College Students' Representation of Image and Verbal Information

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Introduction

One of the more controversial questions asked by cognitive psychologists is whether the representation of information in memory varies depending on the modality of the stimulus. For example, one possibility is that visual/spatial information or images may be processed and stored in a form different from verbal information. An alternative hypothesis is that there is a common mental representation of information independent of modality (Anderson, 1985). This question is of particular interest to researchers interested in deafness, since American Sign Language (ASL) appears to require simultaneous processing of both visual information and verbal information.

Paivio's (1990) "Dual Coding Approach" is one of the most fully developed theories, taking the point of view that the mental representation of information is modality dependent. His theory states that there are two classes of phenomena, verbal and non-verbal, handled cognitively by two separate, but interconnected, subsystems. The non-verbal subsystem is usually referred to as the imagery system because among its functions are the analysis of scenes and the generation and manipulation of mental images. The verbal subsystem refers primarily to functions related to language and language processing.

The subsystems are separate in the sense that one or the other, or both can be active at any given time. They are also separate in that internal representations are modality specific, and performance of memory related tasks are expected to have different characteristics depending on modality. The subsystems are interconnected in the sense that they can activate each other and in that verbal and non-verbal memories may be associated with one another.

The theory posits that a multitude of subsystems is required to affect successful

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functioning given the wide range of activities one has to perform. For example, the language system comprises subsystems including the auditory-vocal subsystem, the subsystem of gestures that make up sign language, the reading subsystem, and the writing subsystem. While the subsystems can operate independently, they also define an integrated whole. Within the whole, the relative importance of subsystems at any particular time is determined in large part by one's experience and by the specific demands of the task in which one is engaged. Dual coding theory claims that the integration of the various subsystems, which make up the verbal and non-verbal systems, and the interrelationships between the systems are sufficient to account for cognition. There is no need for an independent executive to manage the subsystems, nor is there a need for some common mental "language" to facilitate inter-system functions.

Mental representations of non-verbal information preserve information about both individual objects and their relationships to one another. For example, the mental representation of a room full of furniture includes both the individual items of furniture and their relative positions in the room. Further, one can describe the furniture beginning with virtually any item. This suggests that there is no special hierarchical organization of the objects. In contrast, verbal information appears to be organized sequentially. For example, the units of spoken language are organized in a sequential, hierarchical fashion beginning with phonemes and progressing to words, sentences, and more complex structures.

ASL grammatical processing appears to make high demands on visual-spatial perception, memory for images, and mental transformations of images. Since ASL signers practice these abilities frequently, one might imagine signers to be better at non-linguistic tasks which require these skills than non-signers. Emmorey, Kosslyn, and Bellugi (1993) reported results that suggest that deaf and hearing ASL signers display enhanced imagery abilities when compared with hearing non-signers. One might also expect that deaf signers would be very sensitive to the differences between representations of verbal and image information. Thus, deaf individuals present a very attractive population for investigating some of the predictions of dual coding theory.

This study is a replication and extension of an experiment published by Santa (1977). In it, we compared performance on tasks in which the information could be presented either in pictures or in words. Thus, it allows for direct comparison of processing without confounding effects due to differences in the information presented.

Experimental Design and Methods

Santa's (1977) experiment was designed to be sensitive to modality specific processing reflected in response time differences on a simple identification task. His stimuli consisted of common shapes and their names. Stimuli consisting exclusively of pictures of the shapes (which we will refer to simply as "shapes") were considered examples of non-verbal information. Conversely, stimuli consisting of the shape names (which we will refer to as "words") were considered examples of verbal information.

Figures 1 and 2 illustrate the initial and test stimuli used in the experiment, and the instructions for the participants. The initial stimuli consisted of an inverted equilateral triangular array of three shapes or the written names of three shapes. The shapes were chosen from a group of six shapes including square, circle, triangle, diamond, plus, and star. The array was constructed with two of the shapes or words on the top of the triangle and the third at the bottom vertex.

The modality of the test stimulus, shape or word, followed that of the initial stimulus and fit within one of the following ten categories. (The label used to identify each category and the number of trials are included in parentheses.)

1) The stimulus was identical to the original display. (Identical/Array - 8 trials)

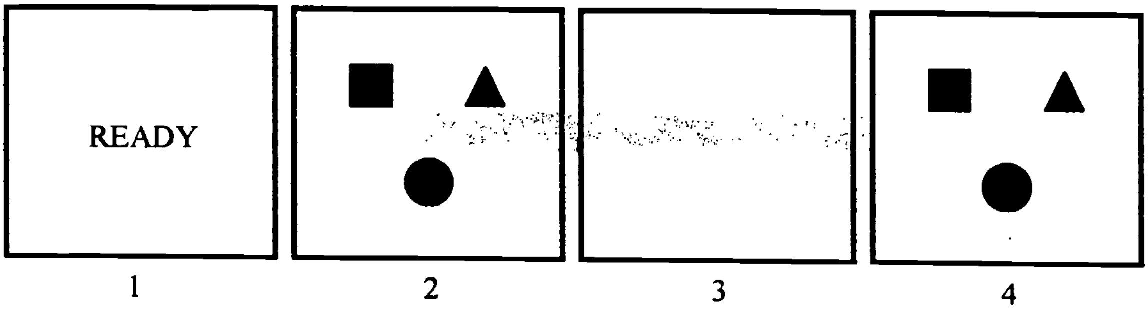
2) The stimulus maintained the triangular arrangement and contained the same shapes or shape names as the original display but they were in a different order. (Transposed/Array - 8 trials)

3, 4, 5) The stimulus maintained the triangular arrangement but contained one, two, or three different shapes or shape names compared to the original display. (Different/Array - 5 trials for each)

In this part of the experiment you will see presentations of **shapes**.

Each trial will show four screens.

Example:



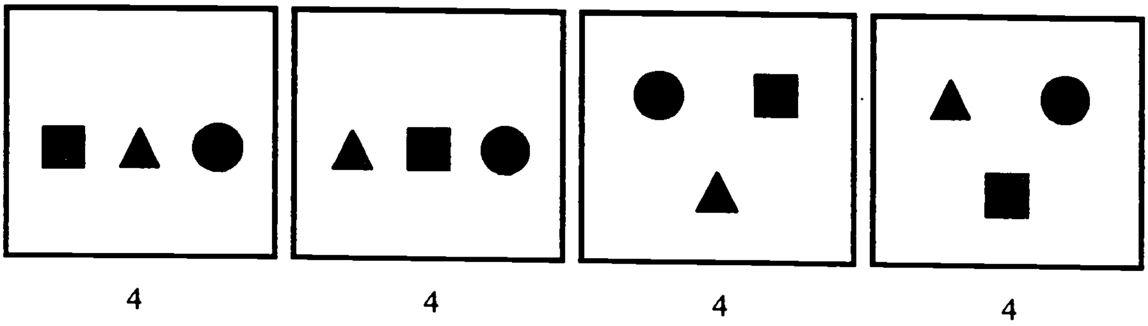
You need to decide if the items in screen 4 are the same as the items in screen 2.

If they are the same press the shift key. If they are different press the option key.

In the example you would press shift because they are the same.

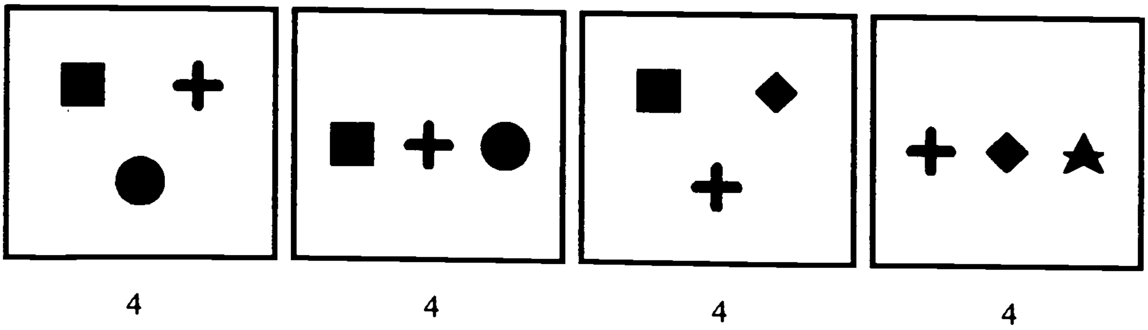
The items can be in any order and still be the same.

The following variations of screen 4 would also be the same as screen 2 in the example.



When one, two or three of the items are different you press the option key.

The following variations of screen 4 would be different than screen 2 in the example above.



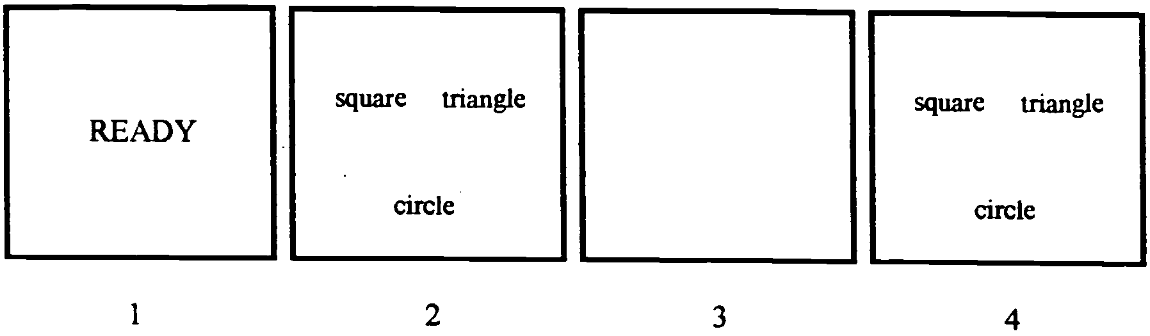
Your responses will be timed so please work as quickly as possible without making mistakes.

Figure 1: Directions for Shape Experiment

In this part of the experiment you will see presentations of **words**.

Each trial will show four screens.

Example:



You need to decide if the items in screen 4 are the same as the items in screen 2.

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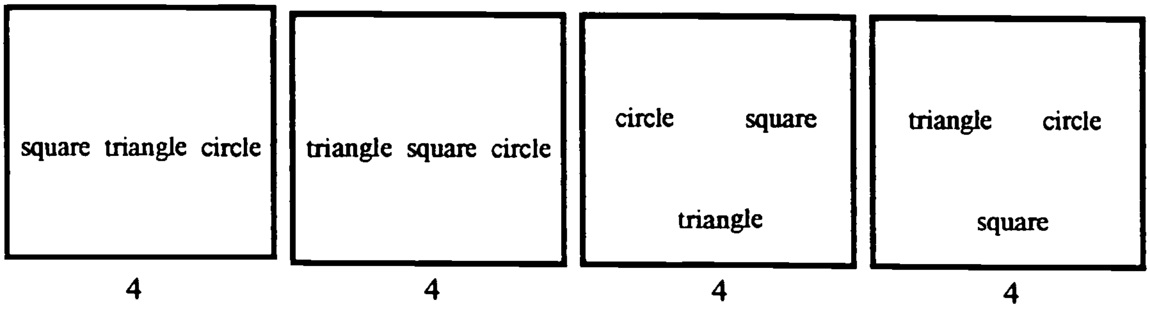
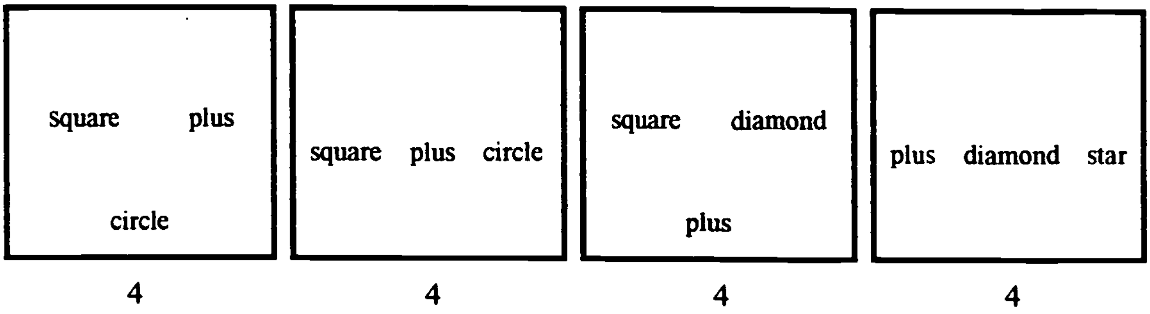


When one, two or three of the items are different you press the option key.

The following variations of screen 4 would be different than screen 2 in the example above.



Your responses will be timed so please work as quickly as possible without making mistakes.

Figure 2: Directions for Word Experiment

6) The stimulus contained the same shapes or shape names in the same order but they were displayed in a single line (similar to how one might print a three word sentence). (Identical/Linear - 8 trials)

7) The stimulus contained the same shapes or shape names but they were in a different order and they were displayed in a single line. (Transposed/Linear - 8 trials)

8, 9, 10) The stimulus contained one, two, or three different shapes or shape names and they were displayed in a single line. (Different/Linear - 5 trials for each)

The experiment itself was conducted using a specially designed HyperCard stack running on a Macintosh SE computer. Once the experiment started the participants interacted directly with the computer without experimenter intervention.

The experiment included two separate parts, one composed of the shape trials, the other composed of the word trials. Each part had 62 trials, 32 trials included the same shapes or words and 30 trials included at least one different shape or word. Approximately half the participants started with the shape trials and the other half started with the word trials. Participants were given as much time as they felt they needed to rest between the two parts of the experiment. None of the participants expressed any discomfort in performing the experimental tasks.

A trial included presentation of the word "READY," centered on the screen for 2 seconds, followed by the initial stimulus for 2 seconds. A 2 second retention period was followed by presentation of the test stimulus. Participants responded by pressing either the "Shift" key, to designate that they felt that the test stimulus included all the same shapes or shape words as the initial stimulus, or the "Option" key to designate that there was at least one different shape or shape word in the test stimulus. Participants were given as much time as they wanted to respond. After detecting a valid response, there was a 2 second rest period before starting the next trial. Participants were encouraged to respond as quickly as they could without sacrificing accuracy and were told that the identities of the shapes were important, not their relative positions.

The response time and the key pressed for each item were recorded by the program. We copied the data to MS-DOS format and ran statistical analyses using SPSS for Windows, Version 7.

Twenty-seven Gallaudet students participated in the study. They were recruited with a general call for interested students and were paid for their participation. All of the data for any particular participant were collected in one session lasting approximately one hour.

Prior to beginning the experiment, we interviewed each participant to learn about family deafness, experience learning sign language, language preferences, and whether there were any special medical or background experiences that might affect performance. Participants were also interviewed after completing each part of the experiment and asked to describe the strategies they used to complete the tasks. Finally, participants permitted us to retrieve their reading test scores from Gallaudet University English department files.

Theoretical Predictions

Dual coding theory predicts that participants will retain the triangular configuration of the stimulus display when it consists of shapes. The theory also predicts that the triangular configuration will not be retained for words. In fact, words might be expected to be retained in a sequential, sentence-like configuration. These expectations lead directly to expectations for response times.

In the case of the shape stimuli, the identical/array configuration of the test stimuli matches the predicted form of the memory trace. Therefore, we expect relatively short response times. The theory predicts that the identical/linear display for shapes requires a mental translation from the triangular to the linear form with a corresponding relatively long response time. Exactly the opposite is true for words. Assuming that words are remembered as sequential strings, the identical/linear form of the test stimuli should yield the shortest response times. Word test stimuli presented as identical/arrays require a mental translation from the linear to the triangular array form and, consequently, a longer response time. The theory is not clear about relative response times for the transformed test stimuli. All transformed stimuli require a translation from the remembered form and, therefore, all are expected to require more time to generate a response. However, the relative time required for array or linear displays is not clearly predicted.

Data Analysis and Results

The basic data for analysis were the response times for correctly identified identical or transposed test stimuli. Test stimuli involving different shapes or words were not included in the analysis and all incorrect responses were deleted from the data. Further, we knew from observing the participants that the first few items occasionally served as training items and that participants sometimes became distracted during the course of the experiment. We were also concerned about possible fatigue effects. To address these problems outliers were defined as (1) response times greater than 3 standard deviations from the mean for the same type of test stimulus, if the test stimulus was among the first or last 3 trials or (2) response times greater than 4 standard deviations above the mean for any other trial. After removing incorrect responses and outliers, the mean response time for each type of test stimulus was computed for each participant. Thus, each participant contributed eight scores to the group analysis: Shape Identical/Array, Shape Identical/Linear, Shape Transposed/Array, Shape Transposed/Linear, Word Identical/Array, Word Identical/Linear, Word Transposed/Array, Word Transposed/Linear.

Most Gallaudet students take two reading tests during their progress through the sequence of required English courses. The first is the locally developed English Placement Test (EPT). Scores on the EPT reading test help determine whether students are required to take non-credit developmental English courses, the placement in the sequence of those courses, and their exit from the program. Students also take the Degrees of Reading Power (DRP) test at the start of the required 4 semester college English program, and some repeat the DRP at the end of the program. We collected EPT and DRP scores for the study participants and computed the group medians. Participants who scored at or above the median were classified “strong readers.” Data for both tests were available for 16 participants and led to consistent classifications in 13 cases. Since the DRP is the more recent measure of reading ability, the classification based on DRP score was used if one was available. In all, it was possible to classify 24 participants based on one or the other reading test.

Data were also available about family deafness. Participants with at least one deaf parent were classified "Deaf-of-Deaf." Originally, we had intended to use family deafness as an independent variable in our analysis of the response time data. However, family deafness and reading ability were very highly related in this group (see Table 1). The large difference in sample size between those participants with deaf parents and those with hearing parents can lead to problems interpreting MANOVA results. Given this potential problem and since most of the participants with deaf families were also strong readers, we chose to use reading ability rather than family deafness as an independent variable in subsequent analyses.

	Strong Readers	Weak Readers	Total
Deaf-of-Deaf	5	2	7
Deaf-of-Hearing	8	9	17
Total	13	11	24
Average DRP Instructional Level Score	90.08 (better than 12th grade median)	62.55 (~ end of year 6th grade median)	

Table 1: Relationship between family deafness and reading ability

Table 2 shows intercorrelations of response times for the different types of stimuli, deafness (measured by the Better Ear Average), and DRP score. The pattern of intercorrelations is interesting in several respects. All of the shape stimuli are highly correlated with one another and, with the exception of Shape Identical/Array, do not show a pattern of relationships with word stimuli. Conversely, word stimuli are highly intercorrelated. This pattern suggests that participants process shape and word stimuli differently. The high intercorrelations with the Shape Identical/Array could be reflecting a baseline like measure of processing speed. Shape Identical/Array is the most "pure" test stimulus in that it is a non-verbal arrangement of non-verbal objects identically presented in both the initial and test stimuli.

Better Ear Average does not correlate with any of the stimulus types except Word Transposed/Linear, or with the DRP. This suggests that hearing loss, per se, has little to do with how participants approached this task, or with their reading abilities.

Finally, DRP correlates highly with all four word stimuli, but not with any of the shape stimuli. This result suggests that reading ability is related to processing speed on very basic verbal tasks. Further, it provides additional support for the hypothesis that shapes and words are processed differently.

		Shape				Word					
		Identity /Array	Identity /Linear	Trans /Array	Trans /Array	Identity /Array	Identity /Linear	Trans /Array	Trans Linear	DRP	BEA
Shape	Identity /Array	1.000	0.680 (.000)	0.705 (.000)	0.690 (.000)	0.512 (.006)	0.330 (.092)	0.536 (.004)	0.484 (.011)	-.132 (.549)	-.214 (.315)
	Identity /Linear		1.000	0.743 (.000)	0.793 (.000)	0.217 (.277)	0.227 (.255)	0.203 (.310)	0.439 (.022)	-.157 (.473)	-.313 (.137)
	Trans/ Array			1.000	0.787 (.000)	0.027 (.892)	0.072 (.720)	0.249 (.210)	0.289 (.144)	0.003 (.989)	-.220 (.303)
	Trans/ Linear				1.000	0.166 (.407)	0.206 (.304)	0.263 (.185)	0.293 (.137)	-.148 (.501)	-.195 (.362)
Word	Identity /Array					1.000	0.812 (.000)	0.754 (.000)	0.656 (.000)	-.524 (.010)	-.230 (.280)
	Identity /Linear						1.000	0.651 (.000)	0.707 (.000)	-.527 (.010)	-.267 (.208)
	Trans/ Array							1.000	0.720 (.000)	-.540 (.008)	-.284 (.179)
	Trans/ Linear								1.000	-.434 (.038)	-.530 (.008)
	DRP									1.000	-.273 (.218)
	BEA										1.000

Table 2: Intercorrelations of test stimuli, DRP, and BEA (p values in parenthesis)

Tables 3, 4 and 5 contain the results of the Repeated Measures Multivariate Analysis of Variance performed to analyze the data. Figure 3 presents the results graphically. In general, the results support dual coding theory and suggest that reading ability helps determine the strategies one chooses to accomplish basic perceptual, short-term memory tasks.

The MANOVA resulted in six significant F rations ($p < .05$). A main effect was found for comparisons; the mean response time for identical test stimuli was faster than that for transformed test stimuli (Table 5a). There was a reading group by modality interaction; strong readers responded more quickly to word stimuli than shape stimuli, while weak readers responded more quickly to shape stimuli (Table 5b). In addition, the difference in mean response times for the strong readers was relatively small, 109 msec, while the difference for weak readers was much greater, 378 msec. A modality by comparison interaction was found; transposition affected word stimuli to a much greater degree, 399 msec, than shape stimuli, 154 msec (Table 5c). Santa's (1977) results were replicated with the modality by configuration interaction (Table 5d). Mean response times for shapes were faster when the test stimulus was an array. Mean response times for words were faster when the test stimulus was linear. We also found an interaction between comparison and configuration (Table 5e). Mean response times were faster for arrays when the test stimuli shapes or words were in the identical position as the initial stimuli. Mean response times were faster for the linear condition when the test stimuli positions were transposed. Finally, we found a three way interaction with modality, comparison, and configuration (Table 5f). The interaction reflects the disappearance of the modality by configuration interaction in the transposed condition.

Test Stimulus Type		Strong Reader (13)	Weak Reader (11)	All
Shape	Identical/Array	1206.723	1123.313	1168.494
	Identical/Linear	1483.356	1354.257	1424.185
	Transposed/Array	1595.372	1381.142	1497.183
	Transposed/Linear	1438.812	1360.940	1403.121
Word	Identical/Array	1157.440	1519.946	1323.589
	Identical/Linear	1120.192	1407.700	1251.967
	Transposed/Array	1516.373	1985.976	1731.608
	Transposed/Linear	1493.907	1818.118	1642.504

Table 3: Mean Response Time by Test Stimulus Type and Reading Ability

Factor	F ratio (significance)
Reading Group	0.61 (.444)
Modality	2.51 (.128)
Comparison	36.62 (.000)
Configuration	0.00 (.982)
Reading Group by Modality	8.23 (.009)
Reading Group by Comparison	0.03 (.863)
Reading Group by Configuration	0.11 (.746)
Modality by Comparison	8.50 (.008)
Modality by Configuration	6.85 (.016)
Comparison by Configuration	8.50 (.008)
Reading Group by Modality by Comparison	0.42 (.522)
Reading Group by Modality by Configuration	1.47 (.238)
Reading Group by Comparison by Configuration	0.20 (.658)
Modality by Comparison by Configuration	4.48 (.046)
Reading Group by Modality by Comparison by Configuration	0.69 (.415)

Table 4: Results of MANOVA

where: Reading Group = Strong Readers vs. Weak Readers
Modality = Shape vs. Word
Comparison = Identity vs. Transposed
Configuration = Array vs. Linear

Identical	1292.06
Transformed	1568.60

Table 5a: Mean Response Time by Comparison

	Shape	Word
Strong Readers	1431.07	1321.98
Weak Readers	1304.91	1682.94

Table 5b: Mean Response Time by Reading Group and Modality

	Identical	Transposed
Shape	1296.34	1450.15
Word	1287.78	1687.06

Table 5c: Mean Response Time by Modality and Comparison

	Array	Linear
Shape	1332.84	1413.66
Word	1527.60	1447.24

Table 5d: Mean Response Time by Modality and Configuration

	Array	Linear
Identical	1246.04	1338.08
Transposed	1614.40	1522.81

Table 5e: Mean Response Time by Comparison and Configuration

	Shape		Word	
	Array	Linear	Array	Linear
Identical	1168.49	1424.19	1323.59	1251.97
Transposed	1497.18	1403.12	1731.61	1642.50

Table 5f: Mean Response Time by Modality and Comparison and Configuration

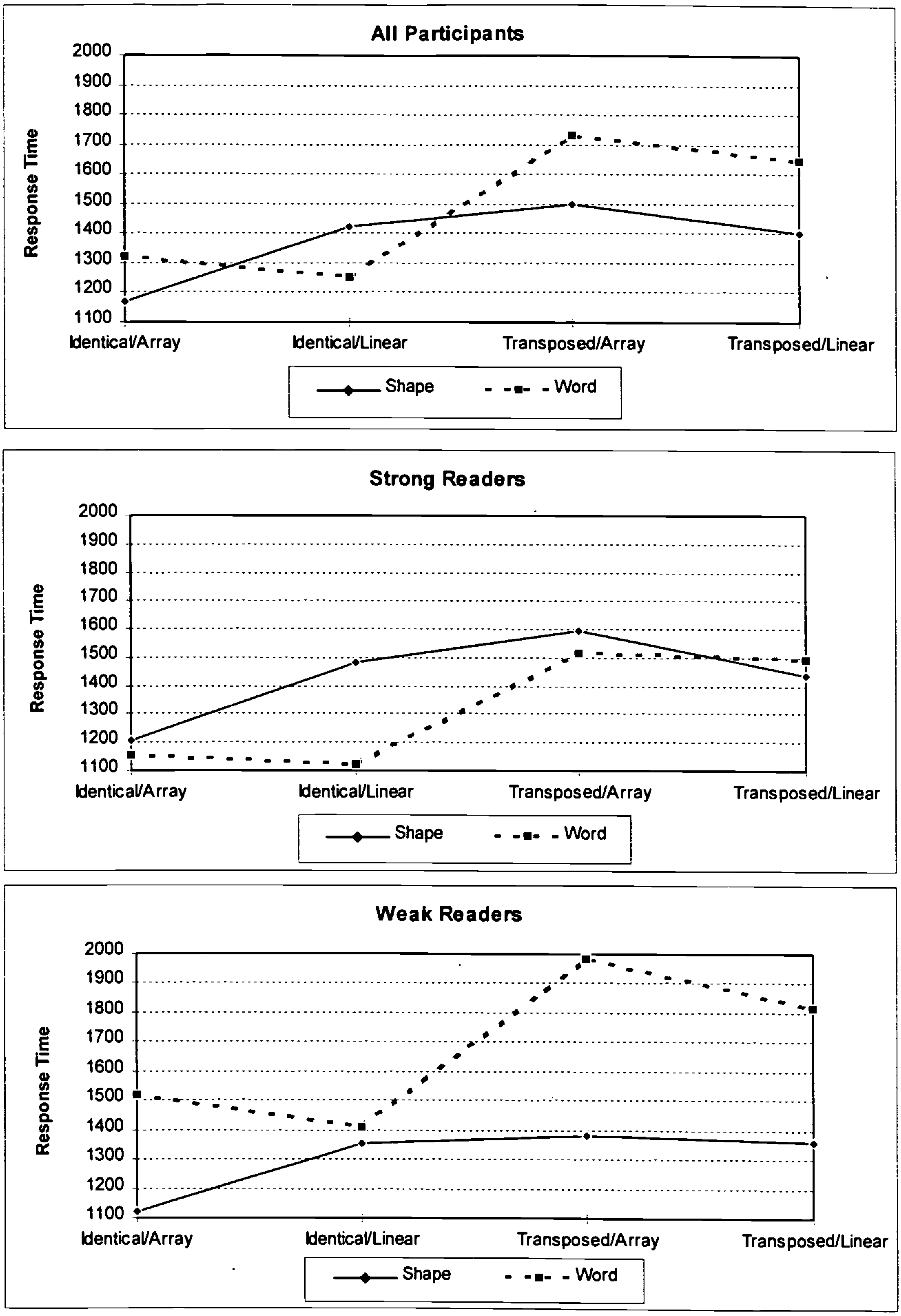


Figure 3: Mean response times (milliseconds) for all participants under all conditions

Discussion

Our initial motivation for beginning this study was to find out if dual coding theory predictions held for deaf individuals. The results do support the theory. The results are also interesting with respect to what they may have to say about reading ability and the strategies individuals adopt for accomplishing cognitive tasks.

The data for all participants clearly show the predicted modality by configuration effect. For initial and test stimuli in which the positions of shapes or words are the same, participants responded to the shapes more quickly when they appeared in an array than when they appeared in a linear format. These data suggest that both the shapes and the configuration in which they were presented were retained. The results were reversed for words. It appears as though individuals retained the word information in a sequential, sentence-like format. The results under the transformed condition also support the modality specific coding hypothesis. The mean response times for the shape identical/linear, transposed/array, and transposed/linear conditions differ by less than 100 msec. A simple explanation for this finding is that all three conditions are different from the initial array condition and all require similar processing to reconfigure the objects prior to making a decision.

The results are quite different for the words. The difference in response times for the identical and transposed conditions is approximately 400 msec, Why did transposing the positions of the words make the task so much more difficult? One possibility is that the sequential order of words is a comparatively strict constraint. The difference in sequential order between words presented in the linear format and those presented in the array format, in the identical condition, is not great. In fact, the definition of identical order is based on the assumption that most people will read the triangular array from left to right and top to bottom. However, the transposed condition does not maintain order at all. If sequential constraints for words are stricter than configural constraints for shapes, one would expect to see results similar to those we obtained.

The results for the strong and weak readers, taken separately, support this explanation. The difference for the strong readers between the linear and array configurations for words in only 37 msec. It appears as though the strong readers are able to ignore the triangular configuration and read the words following the expected sequential constraints. For strong readers we found a relatively large difference between the identical and transposed word conditions of approximately 160 msec. The difference between the word transposed linear and word transposed array configurations is 23 msec. Thus, it appears that strong readers are treating the two configurations of words as essentially equivalent. A transposition must be made, and this is reflected in the increased response time for transposed test stimuli. However, once the transposition is complete, the sequential order of the words dominates over their spatial configuration.

Weak readers appear to have a more difficult time with the word stimuli than the strong readers. In addition to showing consistently slower mean response times, the differences between the linear and array configurations in both the identical and transformed conditions are greater than those for the strong readers. In fact, the pattern of means may suggest that the weak readers have difficulty separating the spatial constraints of the triangular array from the sequential constraints of the words themselves. In other words, the surprising long mean response times for transformed arrays, almost 2 seconds, could be because the weak readers are responding to both the spatial change in the position of the words in the triangle and the sequential change in the words in the "sentence." Perhaps the weak readers cannot abstract the words as relatively pure verbal information from them as objects in a spatial array.

The shape data for the two reading groups, looked at separately, parallel the group data. However, the mean response times for the strong readers are consistently longer than those for the weak readers. In addition, the strong readers generally respond more quickly to word stimuli than shape stimuli, while the weak readers respond more quickly to the shape stimuli. This interaction between stimulus modality and reading ability also supports the hypothesis that different cognitive systems are involved in processing different types of perceptual information.

Assuming, for the moment, that strong and weak readers used different strategies in approaching this task, it is interesting to speculate about whether they were aware of their strategies and whether they can intentionally choose one over the other. Our interview data begin to address these questions.

After completing each part of the experiment, we asked participants what they were thinking about as they worked. Eight of the 13 strong readers said that they used a verbal strategy for both the shape and word experiments. Two of them added that whenever they saw a "plus," whether the shape or the word, they created a meaningful sentence. For example, if the stimulus was "circle, square, plus," they might have rehearsed "circle plus square." This is a remarkable reliance on using language to help short term memory. Two additional strong readers said that they signed to themselves, which may also represent a verbal strategy. Of the three remaining strong readers, one said that he remembered shapes for the shape experiment and words for the word experiment. Interview data for the other two strong readers do not clearly identify a strategy. It appears as though strong readers were aware that they were using a verbal strategy to help them. This suggests that an additional explanation for the relatively long response times for the strong readers is that they had to convert from the verbal representation that they had memorized, to the shapes they actually perceived.

Weak readers were more mixed in their interview results. Six weak readers said that they memorized shapes for the shape experiment and words for the word experiment. Two of the six said that they tried memorizing words for the shape experiment, decided that was too hard, and switched to shapes. One weak reader said that he memorized shapes regardless of whether the experiment involved shapes or words. Three weak readers said they memorized words for both experiments and the interview data was not clear for the remaining participant. These data are interesting in two respects. First, there is more variability among these participants than among the strong readers. Second, two of these participants said that they changed strategies during the task. Not only were they aware of what they were doing, they were able to evaluate their own performance and choose a second strategy which they felt might work better. We don't know how many of the other participants consciously chose their strategies. Can students be trained to be more aware of the strategies they choose to accomplish cognitive tasks, and can they learn to change strategies to be more effective? These results suggest that for simple perceptual tasks, the choice of strategy does have an effect on performance. More research will be necessary to determine how far the results can be generalized.

We stated at the start of this paper that theories that suggest that cognitive processes are modality dependent are particularly interesting when considering ASL. While our data do not permit us to address issues concerning ASL, they do suggest that deaf individuals respond differently to information presented in verbal and non-verbal forms. If that is true, how is ASL perceived? Is it processed in the same way as other forms of verbal information or is some or all of the spatial configuration maintained? How does one's language experience interact with how ASL is processed? Does reading ability have an effect? Do the situation or the task demands have an effect? This study suggests that theories such as dual coding theory may provide a useful framework for investigating these kinds of questions. We feel like we have made a start. Clearly, we have a long way to go.

References

Anderson, J.R. (1985). Cognitive psychology and its implications (3rd Edition). New York: W.H. Freeman and Company.

Emmorey, K., Kosslyn, S.M., & Bellugi, U. (1993). Visual imagery and visual-spatial language: Enhanced imagery abilities in deaf and hearing ASL signers. Cognition, 46, 139-181.

Paivio, Allan (1990). Mental representations: A dual coding approach. New York: Oxford University Press.

Touchstone Applied Science Associates (TASA). Degrees of Reading Power. Brewster, New York.

Santa, J.L. (1977). Spatial transformations of words and pictures. Journal of experimental psychology: Human learning and memory, 3 (4), 418-427.

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