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ABSTRACT

Sixty-four 8-year-old children were divided into fast and slow learner groups and trained on a tactile simultaneous discrimination task. Selective attention was measured in terms of percentage contact time per trial to the relevant dimension. Inter- and intracouplings per trial were also recorded. A multivariate analysis was carried out to examine the role of component factor scores, obtained from a component curve analysis of both the instrumental responses and percentage touching time per trial, and selected cognitive variables in differentiating between the fast and slow learner groups. Percentage touching time factor scores and a memory factor were found to be significant, but there was not significant differences between the groups in the number of couplings made. The results had implications for theories on the role of cognitive activities involved in human learning. (Author)

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SELECTIVE ATTENTION IN FAST AND SLOW LEARNERS DURING DISCRIMINATION LEARNING IN THE HAPTIC MODALITY

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Sixty-four eight-year old children were trained on a tactile simultaneous discrimination task. Selective attention was measured in terms of percentage contact time per trial to the relevant dimension. Inter- and intra-couplings per trial were also recorded. A multivariate analysis was carried out to examine the role of component factor scores, obtained from a component curve analysis of both the instrumental responses and percentage touching time per trial, and selected cognitive variables in differentiating between the fast and slow learner groups. Percentage touching time factor scores and a memory factor were found to be significant, but there was no significant difference between the groups in the number of couplings made. The results were related to selected theoretical positions on the role of cognitive activities involved in human learning.

SELECTIVE ATTENTION IN FAST AND SLOW LEARNERS DURING DISCRIMINATION IN THE HAPTIC MODALITY[1]

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The sequencing of stimuli in a complex learning situation has been analyzed in detail by Gagné (1973) who suggests activating stimuli such as "control over attention" as one possible component of the sequence. Rothkopf (1970) distinguishes between nominal and effective stimuli and suggests that nominal stimuli can be transformed or elaborated by mathemagenic activity, one aspect of which, along with set, information processing, cognition and rehearsal, is attention. Knowledge of how certain aspects of mathemagenic behavior may be activated, such as attentional set activated by the use of interspersed questioning, has been investigated (Rothkopf, 1965; Frase, 1968), but still more information is needed about the underlying processes involved and the relationship of these processes to other variables already known to influence the rate of learning.

One of the underlying processes responsible for facilitating transfer in a discrimination shift task has been selective attention (Zeaman & House, 1963). In the auditory modality dicohtic listening studies (Maccoby & Konrad, 1966; Clifton & Bogartz, 1968), in the visual modality eye-movement studies (White & Plum, 1964) and observing response studies (Eimas, 1969) and in the haptic modality contact time per trial in a discrimination task studies

(Hunt & Fitzgerald, 1973), have been used to attempt to operationally define and study the role of selective attention. The developmental trend of selective attention, that is the increasing ability to focus attention on relevant information, has been investigated by Pick, Christy, and Frankel, (1972). Zeaman & House (1967), summerizing 18 studies concerned with normal and mentally retarded children in the visual modality, concluded that there was a low positive correlation between IQ and discrimination performance. Rieber (1970), however, points out there is little information available with regard to discrimination learning and higher levels of learnings in any modality. The present study attempts to analyze the differences in selective attention exhibited between fast and slow learners during a discrimination sequence in the haptic modality and to relate these differences, if any, to selected cognitive variables.

METHOD

Subjects

The Ss were 32 male and 32 female Grade 3 children randomly chosen from the total Grade 3 population in a mid-western city in Canada. The mean C. A. was 102.5 months.

Apparatus and Stimuli

The two dimensions used in the present study were form and texture. The form stimuli were two-dimensional plastic forms (square and circle) with conductive metal plates cemented to the upper surface of each. The textured stimuli were two milled-aluminium plates. Form stimuli were located on the top and in the centre of the textured stimuli while keeping the form and texture surfaces electrically isolated. The stimulus blocks and plates were presented in a discrimination box which had the side nearest the S covered by a detachable, elasticized, opaque cloth. A metal ring was fastened at the centre of the curtain which allowed the S's finger to make contact with the stimuli. When the S's finger touched the stimulus, a capacitance circuit activated a relay connected to a pen on a six-track ink recorder. If the S's choice response was correct, a green light came on at the front of the box and a candy was deposited into a bag at the side of the apparatus. The pen-and-ink recorder gave recordings of the contact time to each of the two values of the two dimensions and the S's choice responses. A full description of the apparatus and stimuli is given in Hunt & Fitzgerald (1973).

Procedure

Each S was tested individually by a non-correction procedure to a criterion of nine out of ten correct responses. There were two values of the dimension form and two values of the dimension texture. One half of the Ss were trained on form and one half on texture. The eight male and eight female subjects within each of these dimension groups were assigned randomly as they presented themselves for testing. The positive exemplar was varied from trial to trial using a Gellerman series.

Design

The Ss were divided into fast (n = 31) and slow (n = 33) learners by a median cut in the number of trials taken to reach a criterion of nine correct responses out of ten.

The percentage touching time per trial to the relevant dimension and the choice response per trial for each S on the first 10 trials were analyzed by the Tucker component curve analysis technique (Tucker, 1966; Fitzgerald, 1971). Essentially, the Tucker analysis breaks down the average learning curve for a particular population into a series of reference learning curves allowing an individual's learning scores to be expressed as a weighted sum of reference learning curves. More specifically, if x_{ij} is the score on trial j (j = 1, 2, 3, . . . n) for individual i (i = 1, 2, 3, . . . N), then $x_{ij} = b_{1j} y_{i1} + b_{2j} y_{i2} + \ldots + b_{mj} y_{im}$ where the b_j's are factor loadings for the trials, the y_i's are factor scores for the individuals, and 'm' is the number of reference learning curves (components). The factor analysis technique employed to obtain the parameter values is given in Tucker (1966). The problem of the number of reference curves needed to account for the original performance was circumvented in the present paper by taking three components each time and obtaining factor scores for each S on these three components. By utilizing the Tucker technique, it was hoped to obtain a more "pure" learning index for differentiating between the fast and the slow learners.

Ten other measures were also obtained for each S, namely: Detroit Beginners' Test of Intelligence (DETB); Shapes, test of recall of one-dimensional shapes, (SHAP); Gates-MacGintie vocabulary (VCCA) and comprehension (COMP); Stanford Test of Arithmetic (STA); Slosson Oral Reading Test (SORT); Digit Span (DIG); Letters Span (LETT); and two measures for a paired associate task, direct recall (RECL) and delayed recognition (RECO). These 10 measures together with three component factor scores obtained from the choice response (R-W), three component factor scores obtained from percentage contact time per trial (CONT), and the log of the total errors plus one (PRE) were used as a 17 vector variable in a multivariate 2 x 2 (fast-slow x form-texture) design.

The mean number of intra (form-form and texture-texture) couplings per trial and the mean number of inter (form-texture) couplings per trial were obtained for each S for each half of his learning trials by "Vincentizing" each S's trials into two equal blocks. A series of 2 x 2 x 2 (fast-slow x form-texture x 1st half-2nd half) analyses of variance with repeated measures were carried out on each of the intra-form, intra-texture, and inter couplings variables.

RESULTS

The mean vectors of the fast and slow groups in the multivariate analysis were significantly different [$F(17,44) = 10.2$, $p < .001$]. The F ratios for the corresponding univariate F values were non-significant for all variables except the first component factor scores obtained from the analysis of the per trial response [$F(1,60) = 99.9$, $p < .001$], the second component factor scores obtained from the analysis of the per trial responses [$F(1,60) = 3.1$, $p < .10$], the first component factor scores obtained from the analysis of the percentage time spent touching the relevant dimension per trial [$F(1,60) = 18.9$, $p < .001$], the log of the total errors plus one to criterion [$F(1,60) = 137.1$, $p < .001$], and the digit span [$F(1,60) = 3.5$, $p < .10$]. There were no significant main effects for training on form or texture and no significant interactions. Vectors of means for the main effects are given in Table 1.

Insert Table 1 about here

The log of the total errors plus one variable was significant as expected. This result merely substantiates the median split for the fast and slow learners. The significant difference in the first component factor scores from the per trial responses reflect this aspect also. The significant difference in the second component factor scores is much harder to explain. A principal component factor analysis of all 17 variables failed to identify this factor. It had been hoped that this second factor would line up with the first component factor scores obtained from the analysis of the percentage time spent touching the dimensions per trial, thus substantiating the use of the Tucker method as a means of analysing learning data into identifiable component parts. Failure to achieve this may have been due to the initial learning data being dicotohomous rather than continuous. Further research of the use of the Tucker method in this respect is necessary. The first component factor scores obtained from the percentage contact time clearly differentiated between the fast and slow learners. This evidence is further substantiated by Figures 1 and 2 which show the graphs of the backward learning curves (Hayes, 1953) of the percentage touching time per trial and choice responses for the 10 trials prior to criterion in the fast group and the 15 trials prior to criterion in the slow group. The difference in

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Insert Figures 1 and 2 about here

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the percentage time spent attending the relevant dimension between the fast and slow groups is clearly shown. The fact that the digit-span sub-test differentiated between the fast and slow learners probably reflects the short-term memory component involved in a discrimination task. It is interesting to note that the paired associate sub-task was not significant. The processes involved in such a task involve the transfer of information into long-term storage. Such processes do not seem to enter into the task in the present study. It is difficult to see why the letters task, identical in form to the digit task and presumably involving the same processes, should not also be a differentiating variable between the fast and slow groups. The Ss in the present study had been involved in extensive mental arithmetic work prior to testing which may have influenced the outcome. In the present study, no sub-test involving verbal ability differentiated between the fast and slow learners. This is an interesting result in the light of discussions of the importance of verbal mediators in discrimination tasks (Kendler & Kendler, 1962).

The analysis of the number of mean intra-form couplings per trial gave a significant main effect due to blocks [$F\ (1,60) = 24.3$, $p < .001$], with fewer intra-form couplings in the second half of the learning trials than the first half, and a significant main effect due to dimensional training [$F\ (1,60) = 4.54$, $p < .05$], with those trained on form making more form intra-couplings than those trained on texture. There was no significant main effect due to the fast and slow learner groups and no significant interactions. The analysis of the number of mean intra-texture couplings per trial gave a significant main effect due to blocks [$F\ (1,60) = 23.6$, $p < .001$] with fewer intra-texture couplings in the second half of the learning trials. There was no significant main effect due to dimensional training, i.e., those trained on texture did not make more texture couplings than form. One explanation of this difference between those trained on form and those trained on texture may be that it was due to an artifact of the apparatus. Because the form was imposed on the texture, it was more prominent and therefore "attracted" more couplings. The analysis of the mean number of inter-couplings per trial gave a significant main effect due to blocks [$F(1,60) = 80.9$, $p < .001$] with fewer inter-couplings in the second half of the learning trials.

As learning takes place, therefore, the number of intra-form couplings, the number of intra-texture couplings, and the number of inter-couplings, decreases. Further analysis of the couplings showed, that even though there was an overall decrease in the number of couplings, that in the second half of the trials there was a significant interaction [$F(1,60) = 5.36$, $p < .05$] between the dimension Ss were trained on and the mean number of couplings per trial made to the relevant dimension. As learning took place the Ss made more couplings to the relevant dimension than the irrelevant dimension, but again there were no differences exhibited between the fast and slow learners. Table 2 shows the mean-number of couplings per trial for each group.

Insert Table 2 about here

It would appear that as the fast learners spend more time per trial attending to the relevant dimension than do the slow learners, but make no more couplings per trial, the fast learner must extract and process relevant information more efficiently than do the slow learners in the haptic modality. The two processes of orientation and processing information or encoding, which are involved in the process of attention, are not therefore necessarily inclusive. Similar observations have been made in the verbal area (Anderson, 1973). The difference in efficiency of processing information appears, however, to be independent of measured mental ability in the present study. This observation agrees with that of Lehman (1972) who also suggested that intelligence may not be an important factor in the development of selective attention strategies. Furthermore, this difference in efficiency calls into question certain mathemagenic activities that are employed to transfer nominal stimuli into effective stimuli as being effective for all students. Such activities as interspersed factual review and preview questions, which in a sense involve processes of couplings between information in the text and information in the question, are activities which may have varying efficiency for students. Bull (1973) questioned the arousal potential of questions on the learning process. Bull's observations, together with those made in the present study, emphasize the complex nature of the underlying processes involved in changing nominal stimuli into effective stimuli.

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Footnotes

[1]Paper given at the American Educational Research Association Conference, Chicago, 1974.

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TABLE 1

Vectors of Main-effect Means

Variables	Fast		Slow	
	Form	Texture	Form	Texture
PRE	0.27	0.14	0.81	0.94
SHAP	13.1	10.9	13.1	13.6
DETB	107	108	105	107
VCCA	35.4	36.9	35.4	34.9
COMP	23.2	25.9	25.2	23.3
STA	48.4	50.1	49.5	49.9
SORT	93.6	95.4	89.1	82.9
DIG	4.2	4.1	5.6	4.9
LETT	6.3	6.2	6.9	6.0
RECL	7.6	8.2	8.1	7.6
RECO	3.3	3.3	2.6	2.7
FAC1 (R-W)	1.2	1.3	0.75	0.78
FAC2 (R-W)	-0.32	-0.19	0.26	0.00
FAC3 (R-W)	0.03	-0.08	-0.57	0.24
FAC1 (CONT)	1.10	1.18	0.82	0.85
FAC2 (CONT)	-0.06	-0.15	-0.07	0.26
FAC3 (CONT)	-0.36	0.00	0.41	-0.08

TABLE 2

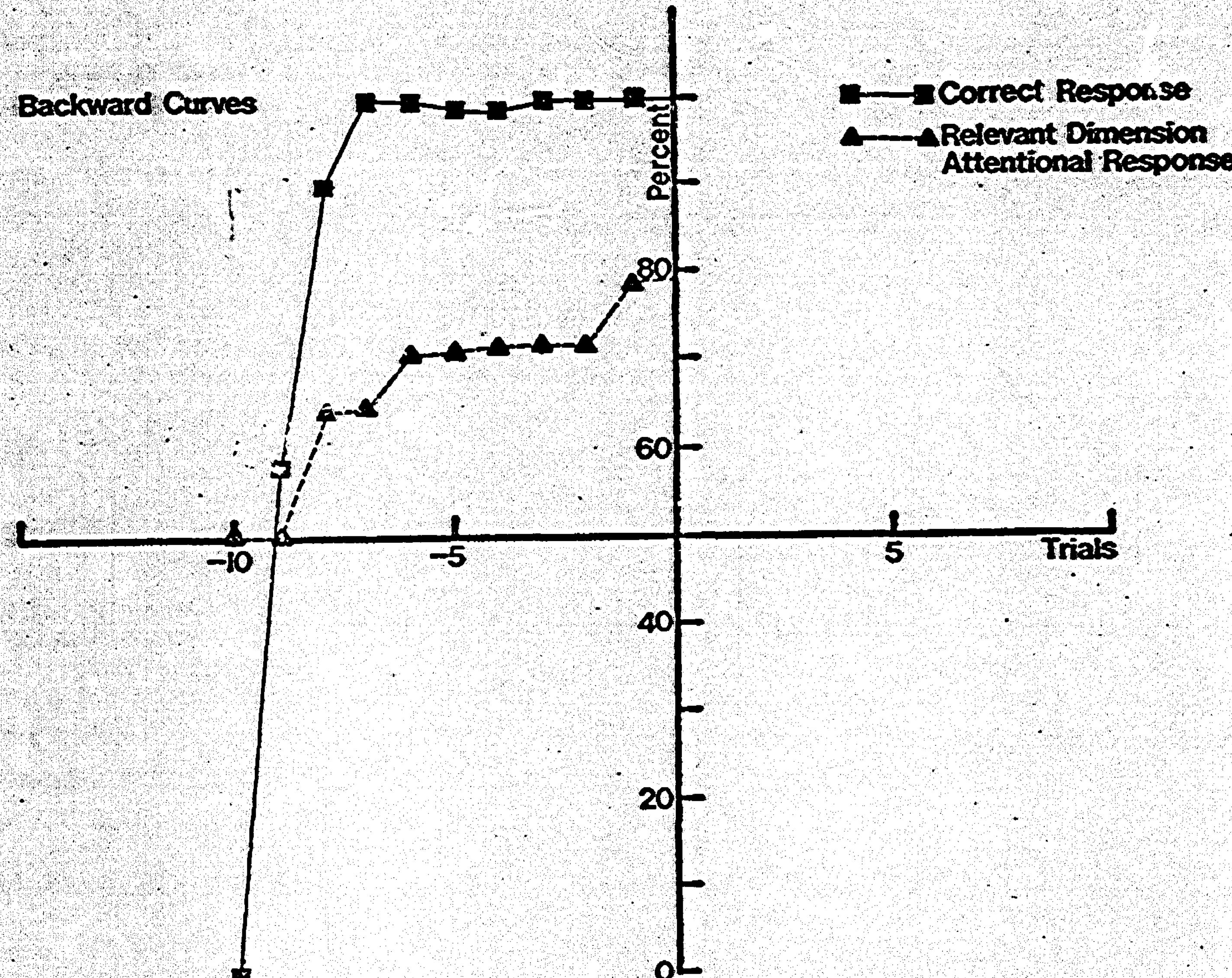
Mean Number of Intra-Form, Intra-Texture, and Inter-Form-Texture Couplings per Trial

		Intra				Inter	
		Form		Texture			
		1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half
Fast	Form	0.67	0.45	1.02	0.58	5.71	2.99
	Texture	0.37	0.16	1.22	0.93	5.15	2.36
Slow	Form	0.64	0.44	1.18	0.63	5.87	3.01
	Texture	0.49	0.24	1.11	0.79	5.32	3.50

Figures

Figure 1. Dimensional contact time per trial and choice response per trial for the fast learning group (n = 31).

Figure 2. Dimensional contact time per trial and choice response per trial for the slow learning group (N = 33).


Backward Curves
Correct Response
Relevant Dimension Attentional Response
Percent
80
60
40
20
0
-10
-5
5
Trials

Backward Curves