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ABSTRACT

The primary purpose for conducting the present experiment was to assess the effects of an associative-attribute--for example, stimulus meaningfulness (m) on the learning rates of different age group children. An attempt was also made to assess the effects of age and m on a measure of subjective organization. This research consisted of two studies: in study one information was obtained on m values for 40 consonant-vowel-consonant words employing children in grades K, 2, and 6. Study two was concerned with the interrelationship between stimulus m and ontogeny on free recall learning rates and subjective organization. It was hypothesized that learning would be more rapid for older relative to younger children when word lists were identical, that is, stimulus m was allowed to co-vary with age. The findings indicated that increasing stimulus m had a within age facilitating effect on free recall learning. (RB)

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Effects of Meaningfulness

on Child Free Recall Learning

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Running head: Free recall learning-subjective organization-meaningfulness

Abstract

Meaningfulness values were obtained on 40 trigrams for kindergarten, second and sixth grade children. Employing these norms in a subsequent free recall learning study, it was found that learning rates and grade level were positively related when meaningfulness (m) was free to vary in same list stimuli. However, learning rate differences were found to be equivalent across grade levels when m was held constant. Implications for child learning research and theory are discussed.

Effects of Meaningfulness on Child Free Recall Learning

It is well established that on the average young children perform less well in verbal learning tasks than do older children and adults (e.g., Gagné, 1968). A number of theorists have attempted to deal with this problem by suggesting that the relatively slow rate of learning in young children is a function of a mediational-deficiency (e.g., Reese, 1962), an inadequacy in their rehearsal and planning strategies (e.g., Flavell, 1970; 1971), or an immature nervous system (e.g., Hebb, 1949). An alternative explanation for the above-mentioned ontological difference is that young children simply haven't the history of experiences to build rich associative networks to verbal stimuli (e.g., Bach & Underwood, 1970). The present article concerns itself with the latter, associative-attribute, view of learning deficits. The particular problem we address is the effects of experience (age) and stimulus-meaningfulness on free-recall learning rates.

Developmental psychologists investigating verbal learning problems typically report that older children perform a free recall learning task more rapidly than younger ones (e.g., Cole, Frankel, & Sharp, 1971; Eysenck & Baron, 1974; Halperin, 1974; Jablonski, 1974; Jensen, Harris, & Anderson, 1971; Shepard & Ascher, 1973; Walen, 1970). Unlike many adult learning studies (e.g., Postman, 1971; Postman & Phillips, 1961), however, where the associative-attributes to verbal stimuli are either investigated or controlled, developmental studies have not been concerned with this aspect of learning. For example, comparative child researchers typically employ words or nonsense syllables in which the associative-attribute norms are derived from adult samples (e.g., Cole et al., 1971; Jensen et al., 1971; Walen, 1970). Under these conditions it is possible that older children learn more rapidly than younger ones because the former have pre-experimentally acquired a greater variety of associative-attributes than the latter; a factor which has been shown to facilitate adult verbal learning rates (e.g., Postman & Phillips, 1961). Bach and Underwood (1970) suggest that when new words are learned by a child, the verbal, associative-attributes to these words are minimal. However, as the child develops and receives more and more educational experiences, he acquires more associative-attributes which in turn become dominant in the memory for words.

The primary purpose for conducting the present experiment was to assess the affects of an associative-attribute, e.g., stimulus meaningfulness, m, on the learning rates of different age group children. An attempt was also made to assess the affects of age and m on a measure of subjective organization. This research consisted of two studies. In Study 1 we obtained m values for 40 consonant-vowel-consonant words employing children in Grades K, 2, and 6. Study 2 was concerned with the interrelationship between stimulus m and ontogeny on free recall learning rates and subjective organization. It was hypothesized that learning would be more rapid for older relative to younger children when word lists were identical, i.e., stimulus m was allowed to covary with age. However, when stimulus m was equated across grade levels, between-age learning rates were not anticipated.

Study 1

Because indices of m for young children were unavailable, our first task was to obtain these values on a set of words for kindergarten, second and sixth grade children. Employing the production method (Kling & Riggs, 1971), Study 1 was specifically designed to obtain m values on 40 trigrams at each of the grade levels mentioned above.

Method

The subjects were 120 children; 40 each in Grades K, 2, and 6 ranging in age from 66-74 months, 78-94 months, and 132-153 months, respectively. The children were Euro-American and were from the same upper-middle economic environment. There were 25 male and 15 female subjects in Grade K, 20 males and 20 females in Grade 2; and, 22 male and 18 female subjects in Grade 6.

The subjects were tested individually in an isolated classroom. The instructions were read as follows:

When you hear a word, sometimes it makes you think of some other words. Today we're going to play a game to see how quickly you can think of words. I will read you a list of words, one at a time. After each word, you tell me as many words as you can. It doesn't make any difference what words you say, as long as the word I say makes you think of it. There are no right or wrong answers. The purpose of the game is just to see how many words come to your mind.

For example, suppose that I say Coat. You might think of Hat, or Man, or Wear, or Warm, or you might think of some other words. Whatever words you think of, tell me right away.

Do you think you understand how to play? Let's practice. Bird . . . . Fine, now let's go on with the rest of them.

The stimuli were 40 consonant-vowel-consonant words selected from Shapiro's (1964) list of 52 trigrams. Six different trigram presentation orders were used. Within each grade level, a minimum of five children were presented the same randomly ordered list.

The child was seated opposite the examiner. Following the reading of the instructions the examiner began by reading each word, one at a time, allowing 18 seconds for the child to emit associations. The examiner wrote down each of the subject's responses. Subjects were given a 3 second rest between the end of each 18 second segment and the next stimulus presentation. An electronic stop-clock was used to measure each temporal interval. The 40 word list required approximately 25 minutes to administer. In order to keep the subject from becoming tense or bored the examiner randomly emitted the words "okay," "fine," or "good" during the 3 second rest.

Meaningfulness values were obtained for each trigram separately by counting the total number of different responses given by each subject, summing over the number of children in each sex by grade group and then taking the average.

Results and Discussion

In a 3 (grade) x 2 (sex) analysis of variance performed on the total number of responses given for each trigram, the only statistically significant effect found was the grade main effect, F (2,234) = 392.15, $p < .01$. The main effectsof sex and the grade x sex interaction were nonsignificant ($ps > .10$). Pair wise F-tests showed that Grade K subjects emitted fewer responses per trigram than Grade 2 ones and Grade 2 subjects emitted fewer responses than Grade 6 children ($ps < .01$). Table 1 presents the

Insert Table 1 about here

average meaningfulness value, i.e., the mean number of responses given to each trigram within the 18 second stimulus presentation time, for each grade level and sex. Rank order correlations performed on the total number of associations per trigram between any two grade levels showed statistically significant positive correlations between Grades K and 2 (rho = +.73), Grades 2 and 6 (rho = +.70); and, Grades K and 6 (rho = +.57), (df = 38, $ps < .01$). These findings indicated that although the average number of associations per trigram increased with grade level, the rank ordering of these words remained relatively stable. Employing the ordinal position data of the 40 trigrams, a rank order correlational analysis was applied to the present study and Shapiro's (1964) sixth grade samples.

Shapiro (1964) had her sixth graders write out their own associations, were group tested, were limited to a maximum of five responses per trigram, and were educated in the northeastern section of the United States; whereas, the subjects in the present study emitted oral responses, were individually tested, were allowed to give unlimited responses per trigram, and were educated in the southeast. Despite these procedural differences, the rank order correlation derived from the number of associations per trigram revealed a high positive relationship between Shapiro's (1964) and the present study's sixth grade samples (rho = +.78, df = 38, $p < .01$).

Study 2

Having gathered the Study 1 norms, we were now able to test the hypothesis that ontogeny and free recall learning are positively related when different age groups are administered the same trigram list; and most importantly, that the relative rates of learning across grade levels are equivalent when stimulus m is held constant.

Method

Subjects were 25 kindergarten, 50 second grade, and 50 sixth grade (mean CAs = 67, 89, and 138 months, respectively) Euro-American children from one elementary school.

Six lists (Lists A, A^1, B, B^1, C, and C^1), each containing seven trigrams, served as stimuli. Within each list attempts were made to control for formal and conceptual similarity and various other possible confounds (e.g., no two words within a list sounded the same or started with the same letter, no two words appeared to be conceptually related, no homonyms, no immediately associative relations between any two words, and no words of foreign origin).

Fifteen kindergarten, 15-2nd, and 15-6th graders learned List A and 10 Grade K, 10 Grade 2, and 10 Grade 6 children learned List A^1 (mean m for lists AA^1 for Grade K = 2.40, Grade 2 = 3.65, and Grade 6 = 5.37). Fifteen 2nd graders learned List B and 10 learned List B^1 (m = 2.38); and, 15 sixth graders learned List C and 10 learned List C^1 (m = 3.65). Thus, comparisons were performed between Group K-AA^1 and Group 2-AA^1 and between Group 2-AA^1 and Group 6-AA^1 where identical stimuli were used and m was allowed to vary. However, Group K-AA^1 vs. Group 2-BB^1 and Group 2-AA^1 vs. Group 6-CC^1 allowed for learning rate comparisons to be analyzed between grade levels while controlling for m. Comparisons between kindergarten and sixth grade children were not possible since the Study 1 results failed to produce an overlap in m values.

All subjects were tested in the same room by the second author. The free recall learning instructions (from Cole et al., 1971) and stimuli were aurally presented at a constant rate via a tape recorder. The inter-word interval was 1.0 second. The tape recorder was stopped when the list was completed and the child was asked to recall the words in any order. This procedure was repeated (presentation order was varied on each trial) until the subject reached a criterion of six out of seven correct responses plus one additional trial or 20 trials had elapsed. Statistical analyses were performed on trials and correct responses to criterion scores and an estimate of subjective organization, e.g., Bousfield and Bousfield's (1966) measure of interitem pairwise comparisons.

Results and Discussion

Table 2 presents the mean number of trials and errors to the learning criterion for the five experimental groups. In order to assess whether or

Insert Table 2 about here

not the trials to criterion variances were homogeneous an F max test performed on the trials data was computed; the results of this test showed that the initial learning scores confirmed the homogeniety of variance assumption ($p > .10$).

Within each grade and m value list 60% of the children learned one set of words and the remaining 40% learned a second set, e.g., Group 2B and Group $2B^1$, respectively. Analyses of variance performed on the trials to criterion scores derived from the two word sets within each grade-m value list showed that Group 2B and Group $2B^1$ subjects learned their lists with equal rapidity as did Group 6C and Group $6C^1$, $Fs < 1.00$. Since the three grades tested in the present study were required to learn the same A-A^1 lists a 3 (K, 2nd, and 6th grades) x 2 ($A + A^1$) analysis of variance was performed on these subjects trials to criterion data. Although the main effect of age was found to be statistically significant, $F(2,69) = 7.83$, $p < .01$, the word list and grade x word list components were not statistically significant, $F(1,69) = 2.46$, $p > .10$ and $F(2,69) = 1.83$, $p > .10$, respectively.

Analyses of variance performed on the trials to criterion scores (trials and correct response analyses were virtually identical) for these five training groups showed a significant effect, $F\ (4,120) = 11.03$, $p < .001$. Subsequent analyses demonstrated that (1) when the same stimuli were used for two different grade levels, and therefore *m* was free to vary, learning was more rapid for older children [Group K-AA[1] vs. Group 2-AA[1] and Group 2-AA[1] vs. Group 6-AA[1]; $F\ (1,48) = 6.57$, $p < .025$ and $F\ (1,48) = 6.25$, $p < .025$, respectively]. (2) However, when comparisons were performed between two different grade levels where *m* values were identical, between grade learning rates were found to be equivalent [Group K-AA[1] vs. Group 2-BB[1] and Group 2-AA[1] vs. Group 6-CC[1]; $F\ (1,48) < 1.00$, $p > .10$ and $F\ (1,48) = 2.16$, $p > .10$, respectively].

Table 2 also indicates that *m* exerted a strong facilitating affect on learning within the second grade sample, i.e., Group 2-AA[1] children reached the learning criterion significantly faster than Group 2-BB[1] ones, $F\ (1,48) = 56.38$, $p < .001$. Although, as Table 2 shows, the sixth grade results are in the predicted direction, statistically significant differences were not found, $F\ (1,48) = 1.82$, $p > .10$. It is possible that sixth grade learning rates were not differentially affected by *m* because the "low" *m* stimuli were in an absolute sense high and as a consequence learning was quite rapid. Although the mean *m* value differences between high and low *m* words were approximately the same <u>within</u> the second and sixth grade samples, the latter groups' stimulus lists were both relatively high. Thus, learning may have developed too rapidly in

Group 6-AA[1] as well as Group 6-CC[1] for between list differences to occur. This finding suggests that in terms of learning rates there is a point of diminishing return as m increases. It is worth mentioning here support for this notion via a post hoc analysis of our initial pilot study. In this experiment 30 kindergarten age subjects served as subjects. Half the children were presented a high m and half a low m list of seven words (m values were 2.38 and 1.82, respectively). The same procedures used in Study 2 were employed in this experiment. Although the mean m list difference between the two kindergarten samples was quite small, it took more than 3 times the number of trials for the low m list children (16.70 trials) to reach criterion than the high m ones (6.20 trials). At present, we are continuing our investigation of the relationship between relative and absolute levels of m using both children and adults as subjects.

Subjective organization was measured by the number of bidirectional observed minus expected interitem pairwise comparisons, O-E (ITR), (Bousfield and Bousfield, 1966) for the three final training trials--the trial prior to 6/7 correct responses, trial 6/7, and the trial following 6/7 correct responses. Mean O-E (ITR) scores are presented in Table 2 for each training condition. A simple analysis of variance applied to interitem data for the five training groups yielded nonsignificant effects, $F(4,120) = 1.25$, $p > .10$. Organizational theorists (e.g., Tulving, 1968) suggest that subjective organization is the primary means by which subjects increase their recall performance of unrelated material. The present results suggest that once a subject approaches a high level of free recall mastery, organizational differences are minimal and fail to reflect variations in learning rates. It is important, however, to make a distinction between initial and subsequent levels of free recall mastery as they relate to organization. Thus, if organization is a necessary condition for learning, then an assessment of organization at criterion should reflect the current and identical high level of performance and not variations in learning rates, e.g., at criterion the levels of organization should be the same and high for all groups regardless of their speed of learning. However, if organization is assessed during a set of precriterion training trials, when group error rate differences are demonstrable, then the levels of learning and organization should be directly related. Trial 1 correct responses (a single trial free recall procedure) and the mean number of O-E (ITR) scores found during Trials 1-2 served as measures of initial learning and subjective organization, respectively and are presented in Table 3. A simple analysis of variance was performed on the number of

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Insert Table 3 about here

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correct responses during Trial 1 and on the Trials 1-2, O-E (ITR) scores. These analyses resulted in statistically significant differences among the five training groups in correct response rates and levels of organization, $F\ (4,120) = 20.72$, $p < .001$ and $F\ (4,120) = 6.71$, $p < .001$, respectively. Inspection of the data in Table 3 support the expectation that when learning and organization are assessed during an initial set of precriterion trials, the two measures are found to be highly related. For example, Group K-AA[1] and Group 2-AA[1] subjects produced an equal number of correct responses during Trial 1, $F\ (1,28) = 2.57$, $p > .10$, as well as similar O-E (ITR) scores, $F < 1.00$. Group 2-AA^1 subjects made more correct responses than Group 2-BB^1 children, $F\ (1,28) = 18.18$, $p < .01$, and the former's level of organization was also found to be greater than the latter, $F\ (1,28) = 5.21$, $p < .05$. Group K-AA^1 subjects tended to make more correct responses during Trial 1 than the subjects in Group 2-BB^1, $F\ (1,28) = 2.84$, $p < .10$. Similarly, Group 6-AA^1 subjects Trial 1 correct response scores were significantly greater than both the children in Group 2-AA^1 and Group 6-CC^1, $F\ (1,28) = 21.91$, $p < .01$ and $F\ (1,28) = 3.51$, $p < .10$, respectively; and, the former group produced a greater number of interitem relationships than the latter two groups, $F\ (1,28) = 9.27$, $p < .01$ and $F\ (1,28) = 4.16$, $p < .05$, respectively. And, finally, Group 2-AA^1 and Group 6-CC^1 subjects failed to differ in their Trial 1 correct response level and in their Trial 1-2 interitem scores, $Fs < 1.00$. In summary, the present results show that both learning rates and organization covaried when assessed during the initial precriterion trials. The assessment of these two measures at criterion were again found to be highly related, but because the data were analyzed when the groups' correct response rates were equivalent between group estimates of organization were also found to be the same.

Conclusions

The results of the present research indicate that multitrial free recall learning rates covary with age when, and only when, associative attributes such as stimulus meaningfulness were free to vary. Statistically significant learning rate differences were not found between children in

Grades K and 2 and children in Grades 2 and 6 when stimulus m was held constant.

The overall findings of the present study indicated that increasing stimulus m had a within age facilitating effect on free recall learning, thereby confirming previous reports by Mickelson (1969, 1970) who worked with nine-year-old children.

With respect to organizational factors the current results offer strong support for the hypothesis that organization is an important if not a necessary condition for free recall learning (Mandler, 1962, 1968; and, Tulving, 1972). Assessing organization at criterion, when the five experimental groups correct response rates were equivalent, resulted in similar levels of organization among these groups. However, when organization was assessed during initial training when the groups were found to vary in their correct response rates, the two measures reflected similar variations in organization.

The main thrust of these results are apparent; they suggest that previous child verbal learning studies (e.g., Cole et al., 1971; Eysenck & Baron, 1974; Jensen et al., 1971; Kokubrun, 1973; Walen, 1970) in which learning rates were found to be correlated with ontogeny, may have been, in part, a function of uncontrolled associative attributes. It should be clear that our results do not deny the theoretical import of the above-mentioned studies, but merely implicate an additional factor. Traditionally, stimulus m's facilitive affect on learning was thought to be a function of mediational processes. According to Glanzer (1962) the greater the number of associations elicited by a verbal unit, the more likely that unit, through mediation, has in forming an association with another unit (see also Mandler, 1967; and Underwood & Schulz, 1960). More recently, encoding-variability has been used to explain the relationships between stimulus m and learning. Martin (1968) suggests that low m stimuli are more variably encoded than high m units and are therefore perceived differently on different occasions, resulting in slower learning rates under low m relative to high m conditions--the former produces more variable functional stimulation than the latter condition. Whether these theories, or alternate approaches (e.g., imagery, processes difference models, or some combination of the above) will eventually emerge as viable explanatory constructs of child verbal learning will be, in part, due to our laboratory control of the developmental aspects of associative attributes.

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Footnote

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Table 1

Average Meaningfulness Values For A List of 40 Trigrams for Grades K, 2, 6

Stimulus Words	Grade K M	Grade K F	Grade K Tot.	Grade 2 M	Grade 2 F	Grade 2 Tot.	Grade 6 M	Grade 6 F	Grade 6 Tot.
BAD	2.28	2.40	2.32	2.80	3.20	3.00	4.04	4.39	4.20
BIG	2.80	2.46	2.67	3.70	3.90	3.80	4.77	5.11	4.92
BOY	2.16	2.66	2.35	3.50	2.95	3.22	4.95	5.50	5.20
BUT	1.60	2.13	1.80	1.95	2.20	2.07	3.13	3.77	3.42
BUY	2.20	1.93	2.10	2.45	2.55	2.50	4.91	5.16	5.02
CAR	2.56	2.93	2.70	4.05	3.85	3.95	5.82	6.05	5.92
COB	1.88	1.80	1.85	1.90	2.20	2.05	4.04	3.72	3.90
COG	1.72	1.53	1.65	1.80	1.35	1.57	3.13	3.89	3.47
COY	1.60	1.40	1.52	1.65	1.50	1.57	2.95	3.16	3.05
DIM	2.08	2.26	2.15	2.40	2.15	2.27	4.22	4.27	4.25
DIP	2.28	2.13	2.22	2.85	2.55	2.70	4.50	4.50	4.50
DOG	2.16	2.93	2.45	4.05	4.25	4.15	5.54	6.22	5.85
FAR	2.00	2.13	2.05	2.60	2.70	2.65	5.09	5.22	5.15
FAT	2.32	2.40	2.35	3.00	3.55	3.27	4.59	4.50	4.55
FUR	2.56	2.13	2.40	3.25	3.45	3.35	5.18	5.61	5.37
GAY	2.04	1.93	2.00	3.10	2.95	3.02	4.27	5.05	4.62
GUN	2.40	2.40	2.40	3.95	3.20	3.77	6.22	5.55	5.92
HAS	1.92	1.93	1.92	2.10	1.95	2.02	2.95	3.89	3.37
HIT	2.32	2.00	2.20	2.30	2.85	2.57	5.00	5.16	5.07
HOP	2.84	2.13	2.57	3.35	3.15	3.25	4.82	5.27	5.02
HUT	1.80	1.86	1.82	3.10	2.85	2.97	5.13	4.83	5.00
JAB	2.00	2.06	2.07	2.70	2.15	2.42	4.72	4.77	4.75
JET	2.32	2.13	2.25	3.95	3.75	3.85	6.13	6.22	6.17
LUG	1.92	2.80	2.25	2.60	2.20	2.40	4.27	4.05	4.17
MAD	2.00	2.46	2.17	3.35	3.20	3.27	3.82	4.27	4.02
MAY	2.04	2.20	2.10	2.70	3.00	2.85	5.86	5.66	5.72
MOW	2.24	2.06	2.17	2.55	2.70	2.62	5.09	5.00	5.05
NEW	2.32	2.66	2.30	2.75	3.05	2.90	4.41	4.66	4.52
NOT	2.20	2.00	2.12	2.60	2.35	2.47	3.54	3.50	3.52
PAY	2.44	2.20	2.35	3.00	3.10	3.05	5.22	4.66	4.97
RAN	2.36	2.33	2.35	3.25	3.20	3.22	5.09	5.44	5.25
RAW	2.00	2.20	2.07	2.45	2.35	2.40	4.50	4.44	4.47
RIB	1.56	1.73	1.62	2.45	2.55	2.50	4.73	4.61	4.67
SAD	2.16	1.93	2.07	2.90	2.60	2.75	3.95	3.27	3.65
SAT	2.00	1.73	1.90	2.95	3.35	3.15	4.27	4.89	4.55
WAN	2.08	2.66	2.15	1.80	2.10	1.95	3.00	4.06	3.17
WAS	2.04	1.80	1.95	1.85	2.30	2.07	3.63	3.16	3.42
WAX	2.32	1.60	2.05	2.80	2.50	2.65	4.63	4.89	4.75
WIN	2.28	2.33	2.30	2.95	3.05	3.00	4.36	4.77	4.55
FEW	2.00	2.20	2.07	2.95	2.85	2.90	4.36	4.16	4.27

Table 2

Mean Number Trials and Errors to Free Recall Criterion and the Mean O-E (ITR) Scores During the Last Three Training Trials

		Condition	Dependent Measures		
Groups	Mean Age in Months	Mean m Values	Trials	Errors	O-E (ITR)
K-AA[1]	67	2.40	8.9	18.0	1.65
2-AA[1]	89	3.65	5.0	5.4	1.75
6-AA[1]	140	5.37	3.3	1.8	2.10
2-BB[1]	89	2.38	11.0	20.0	1.58
6-CC[1]	137	3.65	4.0	3.0	.92

Table 3

Mean Number Correct Responses During

Trial 1 and Mean O-E (ITR) Scores During Trials 1-2

Condition	Dependent Measures	
Groups	Correct Responses	O-E (ITR)
K-AA[1]	3.3	.50
2-AA[1]	3.8	.57
6-AA[1]	5.2	1.13
2-BB[1]	2.6	.16
6-CC[1]	4.1	.64