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ABSTRACT

This study investigates the hypothesis that during adolescence the developmental increase in the tendency to use elaboration as an associative study strategy is explained by increases in metamemorial knowledge. Independent assessments of the metamemorial knowledge and spontaneous strategic behavior of 32 fifth- and 32 twelfth-grade subjects were made. To assess metamemorial knowledge subjects were presented nine hypothetical memory problems and asked for their opinions on strategies for best remembering the material. Scoring took into account choice of strategy and justification of that choice. Strategic behavior was obtained by asking the subjects to verbalize their thoughts while studying each of 36 pairs of concrete nouns by the study-test paired associate method. Verbalizations for each of the pairs were classified into one of 15 categories by two independent raters on the basis of a transcribed record of the tape recorded study trial. Verbalizations were labeled "elaboration" if a direct interaction between the pair members was described. As hypothesied, grade-related advances in metamemorial knowledge appeared to be a powerful predictor of grade differences in use of elaborative strategies. However, results indicate that relevant metamemorial knowledge is neither a necessary nor a sufficient condition for elaboration. (Author/SS)

DEVELOPMENTAL DIFFERENCES IN ELABORATION:

A METAMEMORY EXPLANATION

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A great deal of research, most notably by Rohwer and his colleagues (e.g., Rohwer, 1973; Rohwer, Raines, Eoff, & Wagner, 1977) has been directed at finding an explanation for the rapid improvement in associative learning proficiency which occurs during adolescence. The general consensus of that research is that associative learning proficiency improves because of an increasing tendency to elaborate relationships between the to-be-associated items while studying them. This developmental trend in the use of elaboration as a study strategy seems to represent the progressive loss of a production deficiency, rather than a mediation deficiency, since learners of all ages who fail to elaborate spontaneously benefit from instructions to do so, and it is not uncommon for preadolescents to show some minimal tendency to use the strategy without any special instructions (e.g., Pressley & Levin, 1977).

The next question then, which was addressed by this investigation, concerns <u>why</u> there is a developmental increase in the tendency to use elaboration as an associative study strategy. One possible explanation was suggested by Flavell's (1971) conception of the role of memory-relevant knowledge (metamemory) in directing the selection of strategies to aid learning and memory. For example, the tendency to elaborate items into a relationship seems to require a basic awareness of the utility of item associations, the intent to produce associations, knowledge of the means for doing so, and knowledge of the relative efficacy of different means, such as elaboration. Consequently, the purpose here was to determine whether such metamemorial knowledge develops during adolescence, and if so, whether this metamemory development would explain the increasing tendency to actually use elaboration as an associative study strategy.

Method

Subjects

A preliminary test of the above hypotheses was based on independent assessments of the metamemorial knowledge and spontaneous strategic behavior of 32 fifth- and 32 twelfth-grade subjects. These two groups were chosen to represent the boundaries of the adolescent age range during which the tendency to elaborate develops (cf., Rohwer, 1973). The subjects attended neighboring elementary and high schools in an upper-middle-socioeconomic status community of Los Angeles, California.

Design

The principal factors in the between-subjects portion of the design were grade (fifth vs. twelfth), measurement order (metameory problems before vs. after list learning), list (A vs. B), and sex. A within-subjects factor, metamemory problems (one through nine), was added for some analyses. Grade provided the test of developmental differences. Measurement order provided an indication of the reactivity of the metamemory assessment on list learning strategies, and vice versa. List and sex were included as a check on the specificity of the results. The repeated-measures factor of metamemory problems was included to provide a more detailed picture of grade differences in metamemorial knowledge.

Materials and Procedures

Metamemory. The extent of metamemorial knowledge was determined during a structured interview in which the subjects were presented with nine hypothetical memory problems, in a random order, and asked for their opinions. Table 1 provides a brief summary of those problems. The five asterisked problems were taken directly from the Kreutzer, Leonard, and Flavell (1975) interview study of metamemory development in which kindergarten to fifth grade children were subjects. The

remaining four problems were designed to assess additional aspects of knowledge about alternative associative study strategies and cue-mediated retrieval. Judgments on each problem were scored 1 to 4 or 5 for the amount of knowledge expressed, taking both an objective choice and justification of that choice into account. The scoring criteria are also summarized in Table 1.

Each of the 576 judgments (9 per subject) was scored by two independent raters on the basis of a transcribed record of the tape recorded metamemory interview. Overall, the raters agree 89% of the time in their scoring of the metamemory judgments.

Strategic Behavior. A direct measure of strategic behavior was obtained by asking the subjects to verbalize their thoughts while studying each of 36 pairs of concrete nouns by the study-test paired-associate method. The noun pairs were presented orally by tape recorder at a 15-second rate for a single study trial, followed by a single cued-recall trial during which stimulus cues were presented orally at a 10-second rate. This concurrent measure of strategic behavior was chosen in preference to a postlearning interview about pair-by-pair strategies because of evidence that subject reports after the fact are incomplete and inaccurate (e.g., Montague, Adams, & Kiess, 1966).

The verbalizations for each of the 2304 pairs (36 per subject) were classified into one of 15 strategy categories by two independent raters on the basis of a transcribed record of the tape recorded study trial. Verbalizations for a pair were labeled "elaboration" if a direct interaction between the pair members was described. Verbalizations were labelled as one of eleven other associative study strategies if some relationship (but no direct interaction) was described. The remaining three categories were for verbalizations which could not be classified, or which represented pure rehearsal, or which only described each pair member separately.

Results

Analyses of Variance

The analysis of variance procedure was used to determine the effects of grade, measurement order, sex, and list on each of several dependent measures. Since the main effects and interactions involving the sex and list factors were neither statistically significant nor of particular theoretical import, these factors were omitted from the analyses reported below in order to provide a more sensitive test of grade and measurement order effects. Although effects related to measurement order never reached statistical significance, the relevant means and F values are reported because of practical and theoretical interest in the reactivity of metamemory measurements. All tests were conducted at alpha = .05.

A 2x2 analysis of variance was performed to determine the effects of grade and measurement order on strategic behavior. As can be seen in Table 2, there were sizeable grade differences in the mean frequency of elaboration ($F_{1,60} = 8.64$, $p < .01$) and in the mean combined frequency of the eleven other associative study strategies ($F_{1,60} = 55.87$, $p < .001$). On the average, twelfth graders elaborated twice as often as fifth graders (means of 13.53 and 6.97, respectively) and used other associative strategies five times as often (means of 11.19 and 2.16, respectively). No significant effect was found for measurement order or the interaction of measurement order with grade in either analysis (F's < 1).

A repeated measures analysis of variance indicated there was also a significant grade difference in the amount of expressed metamemory

knowledge ($F_{1,60}$= 45.92, $p < .001$). As can be seen at the bottom of Table 3, twelfth graders attained a mean score of 3.36 on each metamemory problem while fifth graders attained a mean score of 2.51. A more meaningful comparison is in terms of total metamemory scores. Twelfth graders attained a mean total score of 30.24 out of 39 possible, while fifth graders attained a mean total score of only 22.59. There was also a significant difference between metamemory problems ($F_{8,480}$= 23.89, $p < .001$) indicating that the problems were not of equivalent difficulty. The significant interaction of grade with metamemory problem indicated that the magnitude of the grade difference depended on the problem, tending to be largest on the most difficult problems and smallest on the easiest ones. While responding to the metamemory problems after the experience of learning a paired-associate list appeared to improve metamemory scores somewhat, the measurement order effect was not statistically reliable ($F_{1,60}$= 2.25, $p = .14$). Neither was the interaction between measurement order and metamemory problems ($F_{8,480} = 1.55$, $p = .14$). There was no measurement order by grade interaction, or measurement order by grade by metamemory problem interaction (F's < 1).

Multiple Regressions

Once the existence of the developmental trends in strategic behavior and metamemorial knowledge were verified, a hierarchical multiple regression was used to test the major hypothesis of this study, namely that those developmental trends are related.[1]

[1] A separate multiple regression verified the relationship between strategic behavior and cued-recall performance. Frequency of elaboration accounted for 41% of the total variance in cued-recall scores and the combined frequency of the eleven other associative strategies accounted for an additional 29% of the variance; grade accounted for only 4% of the variance which remained after this grade-related variance in strategic behavior was taken into account.

Total metamemory scores, and then grade, were entered sequentially as predictors of the frequency of elaboration. Total metamemory scores were used because they provided a more reliable and global index of relevant metamemory knowledge than scores on the individual problems. The results of the analysis indicated that total metamemory scores accounted for 27% of the variance in the frequency of elaboration ($F_{1,61} = 22.45$, $p < .01$), leaving grade *per se* accounting for literally none of the variance which remained. The relationship between metamemory scores and strategic behavior was even stronger when all associative study strategies were considered. Total metamemory scores accounted for 45% of the variance in the frequency of elaboration plus other associative study strategies ($F_{1,61} = 54.37$, $p < .001$), although grade *per se* now accounted for a small, but significant, 4% of the remaining variance ($F_{1,61} = 4.66$, $p < .05$). Reanalysis in terms of standardized metamemory scores produced almost identical results in each instance.

Discussion

As hypothesized, the sizeable difference between fifth and twelfth graders in total metamemory scores indicates that considerable metamemory development continues to occur during adolescence, at least in regards to the acquisition of knowledge about the utility of item associations and the relative efficacy of different means for producing them. In addition, grade-related advances in the sum total of expressed knowledge appear to be a powerful predictor of grade differences in the frequency with which associative study strategies are actually used, especially when that associative strategy is to elaborate a direct relationship between the pair members.

Nevertheless, cross-classification of subjects by frequency of elaboration and scores on each metamemory problem indicates that relevant metamemory knowledge is neither a necessary nor a sufficient condition for elaboration. Some subjects in each grade who verbalized elaborations during list learning displayed no relevant knowledge on one or more metamemory problems. Conversely, fifth graders who failed to verbalize any elaborations occassionally expressed some relevant knowledge on one or more metamemory problems.

While the notion of a unidirectional, causal relationship, between metamemory development and the tendency to elaborate is challenged by the latter finding, the results of the earlier regression analysis indicate that the relationship cannot be discounted altogether. An alternative explanation, which resolves some of the discrepancy between these findings, is that the developmental relationship is actually bi-directional, or interactive. That is, metamemory development during adolescence may both determine, and be determined by, a developing tendency to generate relationships between to-be-associated items.

The results of a postlearning interview with the subjects provides some support for this interpretation. For example, a few fifth graders were surprised to discover that their occassional unintentional or "automatic" associations were much more effective in aiding recall than the simple rehearsal strategy. A few twelfth graders reported discovering this fact during list learning and thereafter made a deliberate attempt to generate associations. At the next level, many twelfth graders who reported using an associative strategy intentionally from the outset expressed surprise that their occassional production of an <u>unrealistic</u>

relationship between the pair members facilitated their recall as much as their production of realistic ones.

Overall, the interactive hypothesis concerning the metamemory-strategic behavior developmental relationship appears to be both an appropriate and theoretically heuristic interpretation of the findings. Empirically, it provides the best account of the results of the present investigation. Theoretically, it suggests an explanation for metamemory development itself, thereby ending the explanatory chain.

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Table 1

Metamemory Problems:
Description, Scoring, and Interrater Agreement

Description	% Agree	Scoring: Code	Scoring: Judgment
Story-List[a]	85.94		
Judge whether a story facilitates or hinders free recall memory for seven target words		1 = No difference (ignores relationships) 2 = Story harder because target words hard to identify in that context 3 = Story easier (but justification unclear) 4 = Story easier because the items are thematically interrelated	
Sentence	82.81		
Judge equivalence of three 4-pair lists: Same pairs joined by interactive or locational preposition or conjunction (e.g., the watch in/by/and the robe)		1 = No reference to relationships 2 = "By" and/or "and" preferred to "in" because the described interactions are unlikely or unable to occur 3 = "In" preferred to "by" and "and", each of which provide some relationship 4 = "In" preferred; "by" next preferred because provides some relationship; "and" provides no relationship 5[b] = "In" preferred; neither "by" nor "and" provide relationship	
Opposites-Arbitrary[a]	90.63		
Judge equivalence of two 4-pair lists: opposites vs. person-verb pairs (e.g., black-white vs. Mary-walk)		1 = No reference to relationships 2 = Opposites not clearly preferred or not clearly justified 3 = Opposites easier but person-verb pairs not hard because of action relationships 4[c] = Opposites easier and person-verb pairs hard because they could be confused	
Implied vs. Structural Relationship	96.88		
Judge equivalence of three 4-pair lists: common relationship implied (e.g., coin-purse) vs. rhymes vs. same first letters		1 = No reference to relationships 2 = Structural relationship identified and preferred; implied relationships not identified. 3 = Implied relationships identified, but one or both structural relationships preferred 4[c] = Implied relationships identified and preferred to both structural ones	

Description	% Agree	Scoring: Code	Scoring: Judgment
Elaboration vs. Shared Attribute	92.19		
Judge equivalence of three 4-pair lists: amenable to realistic elaboration (e.g., scissors-pants) vs. amenable to unrealistic elaboration (e.g., ball-jar) vs. shared attribute (e.g., wire-thread)		1	= No reference to relationships
		2	= Shared attributes preferred because no relationships in other lists
		3	= Shared attributes preferred or equal to realistic elaborations; unrealistic elaborations equal to realistic ones, or ineffective, or not identified
		4	= Realistic elaborations preferred to shared attributes; "unrealistic" list least preferred because the pairs are hard to elaborate (realistically)
		5[c]	= Realistic and unrealistic elaborations preferred to common attributes
Study Plan[a]	87.50		
Indicate the strategy that would be used to study a 9-item list of categorizable nouns		1	= Rehearsal or implausible strategy
		2	= Alphabetization strategy only
		3	= Some items organized by categories and/or elaboration
		4	= All items organized by categories or two or more elaborations
		5	= All items organized by and within categories or by single story elaboration
Relearner[a]	96.88		
Judge whether a list of birds will be learned more easily by a new learner or a relearner who forgot them		1	= No difference; both starting from scratch
		2	= New learner because relearner's prior experience will interfere with the list's reacquisition
		3	= Relearner (but uncertain or unclear why)
		4	= Relearner because the information is still available in memory (will come back to relearner as he studies)
Retrieval: Event[a]	87.50		
Indicate the strategy that would be used to remember the Christmas that a dog was received as a gift		1	= Implausible or no strategy ("think hard")
		2	= Refers only to external source (e.g. parents)
		3	= Internal-direct: Recall by process of elimination
		4[d]	= Internal-indirect: Recall object, event, or fact temporally associated with receipt of the dog

Table 1, Cont.

Description	% Agree	Scoring Code	Scoring Judgment
Retrieval: Elaboration	82.81		
Judge equivalence of two 4-pair lists in facilitating retrieval: Same pairs connected by stimulus-related or response-related verbs (e.g., the knife cuts/beats the drum)		1 = No reference to relationships 2 = S-related elaborations preferred because R-related ones are improbable; lists equal because balance of realistic and unrealistic elaborations 3 = R-related elaborations preferred because the mediating verb is more likely to elicit the response 4[e] = S-related elaborations preferred because the stimulus is more likely to elicit the mediating verb	

[a] These problems are taken directly from Kreutzer, Leonard and Flavell (1975)

[b] Based on empirical findings (Begg & Young, 1977) and theory (Rohwer, 1973)

[c] Extent of preference for pair-specific over less specific relationships was the scoring criterion (cf., Rohwer, 1973)

[d] Extent of knowledge about cue-mediated retrieval was the criterion

[e] Based on empirical findings (Ehri & Rohwer, 1969) and theory (Rohwer, 1973)

Table 2

Mean Frequency of Associative Study Strategies
by Grade and Measurement Order

Measurement Order	Grade 5	Grade 12	Across Grade
Elaboration[a]			
Problems Before List	8.44	13.00	10.72
Problems After List	5.50	14.06	9.78
Across Order	6.97	13.53	
MSE (60) = 79.75			
Other Associative Strategies[b]			
Problems Before List	2.94	10.69	6.82
Problems After List	1.38	11.69	6.54
Across Order	2.16	11.19	
MSE (60) = 23.36			

[a] Strategy Code 14

[b] Strategy Codes 3 - 13

Table 3

Mean Metamemory Scores by Problem, Grade, and Measurement Order (Problem Before vs. After List)

Metamemory Problem	Grade 5	Grade 12	Across Grade and Order
Story-List			
Before	3.25	3.50	
After	3.13	3.50	
Across Order	3.19	3.50	3.34
Sentence			
Before	1.69	3.06	
After	1.94	3.19	
Across Order	1.81	3.13	2.47
Opposites-Arbitrary			
Before	2.94	3.56	
After	3.31	3.88	
Across Order	3.13	3.72	3.42
Implied Vs. Structural Relationship			
Before	2.19	3.19	
After	2.38	3.69	
Across Order	2.28	3.44	2.86
Elaboration vs. Shared Attribute			
Before	1.38	2.56	
After	2.50	2.94	
Across Order	1.94	2.75	2.34
Study Plan			
Before	2.25	3.81	
After	2.88	3.63	
Across Order	2.56	3.72	3.14

Table 3, Cont.

Metamemory Problem	Grade 5	Grade 12	Across Grade and Order
Relearner			
Before	3.25	3.88	
After	3.06	3.94	
Across Order	3.16	3.91	3.53
Retrieval: Event			
Before	2.81	3.63	
After	2.81	3.69	
Across Order	2.81	3.66	3.23
Retrieval: Elaboration			
Before	1.69	2.50	
After	1.75	2.31	
Across Order	1.72	2.41	2.06
Across Problem and Order	2.51	3.16	

MSE_b (60) = 2.25

MSE_w (480) = .75