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ABSTRACT

Examined were relationships between metamemory and strategic behavior in 130 impulsive and reflective children in fourth, fifth, and sixth grades. Of these, 77 had been tested 3 years earlier on multiple metamemory and memory tasks. At pretraining, children were assessed on metamemory, cognitive tempo, summarization skills, and teacher ratings of impulsive behavior in the classroom. Children in three experimental groups received prose summarization instructions, summarization instructions in conjunction with meta-cognitive training about the importance of a reflective approach to learning, or no instructions. Following training, children were again measured on tempo, summarization skills, and teacher ratings of impulsivity. Analyses of academic strategy use indicated superior performance for children who had received both summarization and metacognitive training. Causal modeling analyses showed early metamemory as a causal antecedent of later strategy acquisition. Discussion highlights the dual importance of metacognitive knowledge as a precursor of later strategy acquisition and metacognitive skills as the "executor" for lower-level strategies. (Author/RH)

# Metacognition and the Development of Strategic Skills in Impulsive and Reflective Children

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## Abstract

This study examined the relationships between metamemory and strategic behavior in impulsive and reflective children. One hundred and thirty children from the fourth, fifth, and sixth grades participated. Seventy-seven of these children had been tested three years earlier on multiple metamemory and memory tasks. At pretraining, children were assessed on metamemory, cognitive tempo, summarization skills, and teacher ratings of impulsive behavior in the classroom. Next, children in three experimental groups received prose summarization instructions, summarization instructions in conjunction with metacognitive training about the importance of a reflective approach to learning, or no instructions. Following training, children were again measured on tempo, summarization skills, and teacher ratings of impulsivity. Analyses of strategy use indicated superior performance for children who had received both summarization and metacognitive training. Causal modeling analyses showed early metamemory as a causal antecedent of later strategy acquisition. The dual importance of metacognitive knowledge as a precursor of later strategy acquisition and metacognitive skills as the "executor" for lower-level strategies are highlighted.

# Metacognition and the Development of Strategic Skills in Impulsive and Reflective Children

The tendency to reflect or not reflect before responding on problem solving tasks with response uncertainty is an aspect of cognitive style. Children who delay responding until all possibilities have been considered, thereby making few errors, are called reflective, while those who respond quickly and are less accurate are called impulsive (Kagan, 1966). An impulsive response style is associated with inefficient problem solving behaviors, failure to generalize newly learned strategies, and an inability to exercise self-control in social situations (Ault, 1973; Borkowski, Peck, Reid, & Kurtz, 1983; Cameron, 1984; Denny, 1973; Kendall & Finch, 1979; Victor, Halverson, & Montague, 1985).

Although most early training studies designed to reduce impulsive responding were successful in modifying self-control on the targeted task, treatment effects often failed to transfer to classroom tasks or to other settings (Douglas, Parry, Martin, & Garson, 1976; Meichenbaum & Goodman, 1971; Palkes, Stewart, & Freedman, 1972). Some recent studies, however, have reported strategy generalization. Bryant and Budd (1982) used self-instructional training in a single-subject design to increase the on-task behavior of impulsive preschoolers; training resulted in increased levels of accuracy on classroom worksheets. Other studies have reported generalized improvements on the Matching Familiar Figures Test, Porteus Maze, performance IQ (WISC), and teacher

ratings (Bornstein & Quevillon, 1976; Camp, Blom, Hebert, & VanDoorninck, 1977; Kendall & Finch, 1978).

At a theoretical level, motivation, self-understanding of learning problems, knowledge of cognitive processes (metacognition), and attributional beliefs have been identified as interrelated factors that influence the maintenance and generalization of treatment effects (Borkowski et al., 1983; Bugenthal, Whalen, & Henker, 1977; Douglas, 1980; Meichenbaum & Asarnow, 1978; Schleser, Meyers, & Cohen, 1981). Of these, metacognition occupies a paramount position in explaining the origins of impulsive behavior as well as transfer failures (Borkowski, Reid, & Kurtz, 1984; Stober, 1985). The metacognitive deficit associated with impulsivity can be of two types: knowledge about memory strategies (such as rehearsal, elaboration, or organized memory search) or knowledge about executive processes (such as monitoring, strategy selection, or strategy modification). As is too often the case with handicapped learners, impulsive children are deficient in both types of metacognitive knowledge. they possess fewer and less sophisticated memory strategies than reflective children (Borkowski et al., 1983) and have immature executive functioning (cf. Douglas, 1980; Meichenbaum & Genest, 1980). These are important deficits since strategy transfer depends on the child's prior knowledge about strategies, knowledge of their usefulness, and the executive processes necessary for strategy implementation (Palincsar & Brown, 1984; Pressley, Borkowski, & O'Sullivan, 1985).

Borkowski et al. (1983) concluded that strategy

maintenance and generalization in impulsive and reflective children are mediated by metamemorial processes. Evidence came from two sources: (1) Strategy transfer and metamemory scores were higher for reflective than for impulsive children, and (2) correlations between metamemory and strategy use remained significant when cognitive tempo was partialed out, whereas tempo-strategy use correlations became nonsignificant when the effects of metamemory were removed. According to our hypothesis, an impulsive style impedes metamemorial development, with poor metacognition rather than an impulsive response style being proximally responsible for failures in strategy transfer. Poor metacognition, in turn, hinders the acquisition of new learning strategies. In this way, impulsivity influences metamemory, which serves as the mediator between tempo and strategic behavior. Previous support for this hypothesis has relied largely on correlational evidence collected at single time frames in the development of impulsive response styles (Borkowski et al., 1983; Browning & Cavanaugh, 1985; Smith, 1985).

In the present study, a longitudinal design and causal modeling procedures were employed to assess the relationships among metacognitive knowledge, tempo, and strategic behavior, within the context of training reading comprehension strategies. Fourth, fifth, and sixth graders were taught a procedure that enabled them to write clear summaries of prose passages. Three years earlier, these children had been tested on metamemory and tempo as first, second, and third graders. The original data, reported in Borkowski et al. (1983),

served as the starting point for examining long-term patterns that link metacognition, tempo, and strategic behaviors as they underlie prose comprehension. The intent was to observe the impact of early cognitive style and metacognitive knowledge on the later acquisition of reading strategies, and to observe the developmental connections between tempo and metacognition.

The rationale for focusing on reading comprehension is related to its presumed reliance on the course of early metacognitive development (Baker & Brown, 1984; Forrest-Pressley & Gillies, 1983; Palincsar & Brown, 1984). Jones, Monsaas, and Katim (1979) have argued that reading comprehension requires effective memory skills which are greatly influenced by learning strategies. Moreover, Paris and Lindauer (1980) noted that poor readers, many of whom have impulsive styles, often use inefficient decoding, comprehension, and study strategies, tending to focus on single words and ignore grammatical structures that aid comprehension. Beginning and poor readers do not actively monitor comprehension, and consequently do not engage in self-correction to the same extent as good readers (Baker & Brown, 1984). All of these factors implicate lower- and higher-order metacognitive skills in the emergence of reading comprehension skills.

Thus the purpose of the project was two-fold: (1) to assess the learning and transfer of an important academic strategy as it was influenced by prior metacognitive knowledge and the training of subordinate (strategy) and superordinate (executive) processes, and (2) to further examine

the long-term relationships among metamemory, impulsivity, and strategy use. Three treatment conditions were included: a Strategy condition received instructions on how to summarize descriptive and explanatory paragraphs, adapted from the Chicago Mastery Learning/Learning Strategies curriculum (Jones et al., 1979); an Executive condition received the same summarization instructions but was also given metacognitive information about the value of monitoring performance, importance of deliberate strategy selection and modification, and necessity to work slowly and carefully; an attention Control group spent equivalent amounts of time with the experimenter summarizing paragraphs, but received no strategy or metacognitive instructions. Executive training was expected to provide procedural knowledge necessary for successful strategy transfer, especially for those children with a history of immature metacognitive and strategy development (Hasselhorn & Körkel, 1985; Paris & Jacobs, 1984). Finally, the longitudinal components of the design allowed the testing of causal models, clarifying the developmental patterns operating among metacognition, cognitive tempo, and learning strategies in young children.

## Method

### Subjects

Children from two parochial schools in South Bend, Indiana, served as subjects in this experiment. The first part of the study used 135 children from the first (N = 39), second (N = 55), and third (N = 41) grades. The second part of the study, conducted three years later, was based on a

total of 130 subjects from the fourth (N = 52), fifth (N = 51), and sixth (N = 27) grades. Seventy-seven of the 130 were part of the original sample.

The numbers of males and females were approximately equal within each age group. About 90% of each sample was white. Of the 77 children tested in both phases, 28 were impulsive as indicated by scores on the Matching Familiar Figures Test (Cairns & Cammock, 1978), 32 were reflective, 5 were slow-inaccurate, 5 were fast-accurate, and 7 scored at the median on errors, latency, or both. Of the 130 children tested at the second measurement point, 56 children were impulsive, 57 were reflective, 4 were fast-accurate, 4 were slow-inaccurate, and 7 scored at the median. The numbers of impulsives and reflectives at each grade level were approximately equal. The median error rates on the Matching Familiar Figures Test were 13, 10, and 7 for fourth, fifth and sixth graders, and median latencies were 13.04, 14.95, and 15.88, respectively.

Design

In the first part of the study, which was reported in Borkowski et al. (1983), first, second, and third graders were tested on a metamemory battery and the Matching Familiar Figures Test (MFFT). Three years later, all old and new subjects were tested on the MFFT in Session 1. In Session 2, responses were obtained on a metamemory battery. Children were given a pretraining assessment of summarization abilities, and the Vocabulary and Information subtests of the WISC in Session 3.

Next, children at each grade level were divided into three groups, two experimental groups and one control group. Assignment to groups was random; however, groups were approximately equivalent at each grade level on metamemory, cognitive tempo, and summarization scores. All children who had participated in the earlier experiment were assigned to the two experimental groups, whereas the attention control group consisted entirely of children who did not participate in the earlier study. Children who participated in both studies were all assigned to the two experimental groups so that a larger sample size might be used in the causal modeling analyses, which were conducted only with the two trained groups. It is likely, however, that participation in the earlier experiment was unrelated to later performance; although a similar metamemory test was used in both test periods, the strategies trained and the procedures used were quite different. The addition of new subjects was necessary in order to document the overall success of strategy training, which was of less interest than the comparison of executive versus strategy training (a comparison not confounded by participation in phase 1), and the model testing.

Training was conducted during Sessions 4 through 6. In Session 7, children were asked to write summaries of new prose passages with no mention of the earlier training procedures, and were again measured on the MFFT. Teacher ratings of impulsive behavior in the classroom were obtained before Session 4 and after Session 7. The experimental sessions were separated by approximately two-week intervals.

Scores from the Reading Comprehension portion of the Iowa Test of Basic Skills were obtained from school records. Pretraining Iowa scores were measured between Sessions 1 and 2. Posttraining administration of the Iowa test occurred one month after Session 7.

Materials

The early metamemory test was composed of four subtests from the interview battery designed by Kreutzer, Leonard, and Flavell (1975) (Story List, Preparation Object, Retrieval Event, and Rote Paraphrase); a Memory Monitoring task similar to one used by Levin, Yussen, DeRose, and Pressley (1977); and an Interest Categories task recently developed by Kurtz, Reid, Borkowski, and Cavanaugh (1982). Details of administration and scoring may be found in Kurtz et al. (1982). The later metamemory test included the six subtests used previously (Story List, Preparation Object, Retrieval Event, Rote Paraphrase, Memory Monitoring, and Interest Categories), and three new subtests (Spelling, Social Studies, and Science Test). The new items measured metacognitive knowledge of study skills and learning strategies. Rote Paraphrase was expanded in the later testing to provide a more stable measure of metareading.

Materials for the prose summarization tasks were adapted from the Main Ideas and Details, Topic Sentences, and Summarization sections of the Chicago Mastery Learning/Learning Strategies Program Curriculum, levels J to L (Hannon, 1979). Materials for pre- and posttraining assessment of all children and "training sessions" for the attention control

group consisted of prose paragraphs which the children were asked to summarize. The pretraining task included three descriptive and two explanatory paragraphs; posttraining included four descriptive and two explanatory paragraphs. Materials for the two experimental groups included worksheets and written examples of topics and their component parts, as well as descriptive and explanatory paragraphs.

The Cairns and Cammock (1978) Matching Familiar Figures Test consisted of two practice items and 20 test items. The Conner's Abbreviated Teacher Rating Scale (1969) was used to obtain teacher ratings of impulsive behavior.

Procedure

All testing was conducted individually in a quiet area near the child's classroom. Sessions lasted 20-30 minutes with no time constraints. In the first part of Session 1 children worked through the MFFT practice items. The experimenter then displayed the standard and comparison pictures, recording the number of errors and latency-to-first-response of each item. In Session 2, the metamemory battery was administered.

In Session 3, each child was tested on the Information and Vocabulary subtests of the WISC. Then the child was given five paragraphs of fourth and fifth grade reading level, and was told to read them and summarize each in a single sentence. Queries about word meanings were encouraged. Responses were scored according to the following criteria: inclusion of the subject or topic word (two points), statement of the main idea (two points), statement of the reason (two points,

explanatory paragraphs only). One point was deducted when extraneous information was included. Interscorer reliability was 96% for this task. At this juncture, teachers were instructed to complete the Conner's scale for each child.

During Sessions 4 through 6, children in the Strategy and Executive groups received summarization skills instruction. Children were told that the procedures would help them be better readers. At the beginning of each session, the child reviewed information covered in earlier training sessions, and performed exercises which assessed his or her grasp of the material. If the child experienced difficulty with the exercises, the experimenter returned to material covered in previous sessions, giving additional instruction until the child demonstrated mastery. Session 4 focused on distinguishing between a category name and exemplars from the category. First the child identified topic names within lists of words, or supplied a topic name when it was missing. Then the experimenter explained that a paragraph also has a topic or main idea, and parts that say something about the main idea. During the remainder of the session, the child practiced identifying topic sentences within descriptive paragraphs. In Session 5, children learned to create a topic sentence when it was missing. The idea of a summary was discussed, and a self-questioning procedure was introduced to help in summarization. (E.g., "What is this story about? What is the main idea in one word? What is the most important thing about the main idea?") In Session 6, the child learned to summarize explanatory paragraphs. A three-step strategy

was introduced: (1) Identification of the main idea sentence. ("What is this paragraph about?") (2) Identification of the reason. ("Why?") (3) Combination of the main idea and reason into a summary statement. Session 6 ended with exercises which distinguished between explanatory and descriptive paragraphs, and an extensive review.

Children in the Executive group received summarization instructions in the same manner as the Strategy group. In addition, at the beginning of each training session they received short lectures on "How the Mind Works". Each child engaged in active and creative dialogue with the experimenter during this instruction. In Session 4, the experimenter emphasized that problem solving or learning situations may be approached in many different ways, and a tactic that works well in one setting may be inefficient in another. Strategy selection and modification were described and then specific examples, academic and non-academic, were given. Session 5 included a review of Session 4 Executive material, and a discussion of the importance of working slowly. Children were told that it is advantageous to be fast and accurate, but if one must sacrifice speed or accuracy, it is better to do the job well than to finish first while performing poorly. In Session 6, the importance of matching study and retrieval strategies was discussed. The ideas of strategy monitoring to determine progress and strategy modification were also re-emphasized. Executive instruction in all three training sessions was applied on the summarization task through the use of examples and questions directed to the child about

reading and comprehension strategies. Each training session began with a reminder of previous executive instructions, and a new segment of the dialogue. After the discussions of how the mind works in Sessions 4 to 6, children in the Executive group received summarization instruction. Throughout the summarization skills exercises, children were reminded of the importance of working slowly, monitoring performance, and evaluating strategy efficacy.

Children in the Control group were instructed to read paragraphs and write summary statements in Sessions 4 to 6. Paragraphs given to the Control children were identical to those used in the worksheets for the experimental group training. In order to equate treatment time in the experimental and control conditions, the experimenter engaged each child in conversation about classroom activities. However, no mention was made of the learning strategies or executive processes. Children in all groups were told that the summarization exercises would help them to be better readers.

In Session 7, maintenance and generalization of training was examined with new paragraph summarization exercises. Children in all conditions received identical instructions for the exercises; no mention was made of the training procedures. Finally, the MFFT and teacher ratings of impulsive behavior were obtained.

## Results

### Training Effects

A significance level of $p < .05$ was used throughout the analyses to be reported in this section. Scores for each

summary statement were summed across paragraphs to yield a single summarization score for each subject at pretest and posttest; mean summarization scores at posttest adjusted for pretest summarization scores are reported in Table 1. A 3(Grade) x 3(Condition) x 2(Tempo) analysis of covariance on posttraining scores, using pretraining summarization as the covariate, showed significant main effects of Condition and Tempo, $\underline{F}(2,94) = 10.59$ and $\underline{F}(1,94) = 5.04$, respectively. None of the interactions was significant.

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Insert Table 1 about here

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The Bryant-Paulson generalization of Tukey's test was used for all contrasts among means adjusted for covariates (Huitema, 1980). Harmonic means were used in comparisons involving unequal cells. Analysis of the main effect of Condition showed that children in the two experimental conditions were better summarizers than children in the Control condition. Furthermore, children in the Executive condition were better than those in the Strategy condition, $Qp(1,3,109) = 11.71$ and $Qp(1,2,110) = 3.63$, respectively. Additional comparisons showed that reflective children were better summarizers after training than impulsive children, $Qp(1,2,110) = 3.37$. Reflective and impulsive children did not differ, however, on summarization scores before training.

Reading Comprehension scores from the Iowa Test of Basic Skills administered before training were available for 65 children. An analysis of variance on these comprehension

scores showed no differences among experimental groups before training. Iowa Basic scores obtained after training were available for 27 children; pretraining scores for those children were not available. A oneway analysis of variance on posttest scores showed a significant main effect of Condition, $F(2,24) = 4.17$. Planned comparisons showed that children in the Executive and Strategy conditions comprehended and recalled more on the Iowa Test than children in the Control group, $F(1,24) = 6.86$. The Executive and Strategy conditions did not differ from one another.

Error and latency scores from the Matching Familiar Figures test were converted to $z$ scores within grades and sessions. The $z$ score for errors was subtracted from the $z$ score for latencies to yield a single tempo score for each child (Salkind & Wright, 1977). With this index, reflective children should exhibit positive scores, and impulsive children negative scores. These tempo measures were derived within grades in order to obtain peer-relevant measures of tempo.

A 3(Grade) x 3(Condition) x 2(Metamemory) analysis of covariance was performed on posttraining tempo scores, using pretraining tempo as the covariate. The two levels of metamemory (above and below the median within each grade) were included to determine if high and low metamemory children benefited from training differently. The Grade x Condition interaction and the main effect of Condition were significant, $F(4,111) = 2.55$, and $F(2,111) = 3.15$. Bryant-Paulson comparisons showed no significant differences in tempo scores

among xperimental conditions for fourth graders. Fifth grade children in the Executive condition were more reflective after training than fifth grade Strategy and Control children, and children in the sixth grade Strategy condition were more reflective than sixth grade Control children, $Qp(1,3,126) = 5.42$ and $Qp(1,2,127) = 3.01$, respectively. All other group comparisons within grades were nonsignificant. Bryant-Paulson comparisons analyzing the main effect of Condition found no significant differences among experimental groups at the .05 level. Mean tempo scores for the Executive, Strategy, and Control conditions were -.04, .20, and -.34, respectively. A 3(Grade) x 3(Condition) analysis of covariance on teacher ratings from the Conners scale after training, using pretraining Conners scores as the covariate, was nonsignificant.

In summary, strategy training was successful as evidenced by improved summarization scores at posttest for those children in the experimental conditions. Interestingly, Executive training had an additional impact on summarization, as posttraining scores were higher across grades for children in the Executive condition than children in the Strategy condition. Changes in tempo scores were less clear: fifth grade Executive children were more reflective than other fifth graders after training, but fourth and sixth graders did not show this effect.

Training, Tempo, and Metamemory

Metamemory scores from the nine subtests were summed within categories (elaboration: Story List; task characte-

ristics: Rote Paraphrase and Interest Categories; monitoring: Memory Monitoring; strategies: Retrieval Event and Preparation Object; and study skills: Spelling Test, Social Studies, and Science Test). The five category scores were converted to z scores and summed to yield a composite metamemory score for each child which gave equal weighting to the different types of metacognitive knowledge represented. Separate z distributions were constructed within each grade.

Summarization scores from Session 7 were correlated with metamemory scores within groups to determine the impact of prior metamemory on gains due to training. Because summarization scores were not standardized within grade, partial correlations were computed removing the age effects. Second-order partials were computed to also remove the effect of pretraining summarization. Following training, metamemory was significantly related to summarization skills only for the Executive condition, $r(49) = .39$. Similarly, correlations between summarization scores and metacognitive knowledge about reading (Rote Paraphrase) were significant only for the Executive group, $r(49) = .27$. The correlation between summarization scores and the remaining metamemory subtests was also significant, $r(49) = .44$. Evidently, children who were high in metamemorial knowledge before training profitted the most from the Executive instructions. Although metamemorial knowledge about reading was also related to improvements in summarization, the relationship was not as strong as the overall metamemory-summarization relationship, perhaps because of the small number of items in the Rote Paraphrase

subtest.

Posttraining summarization scores were correlated with tempo and teacher ratings within groups to determine the impact of tempo on training. Partial correlations were then used to remove the effects of age and pretraining summarization. Tempo-summarization correlations at posttest approached significance for both the Executive and Strategy conditions, $r(49) = .227$ and $.223$ ($p < .06$), but not the Control condition. These correlations indicated a positive relationship between a reflective response style on the MFFT and improvement in summarization ability. Posttraining Conners scores were significantly correlated with posttraining summarization scores only for the Strategy and Control groups, $r(49) = -.375$ and $-.434$, respectively, indicating a positive relationship between classroom reflectivity and summarization. Pretraining tempo-summarization and pretraining Conners-summarization correlations were nonsignificant for all conditions.

Thus, training effects were influenced by both tempo and metamemory. Because pretraining tempo-summarization correlations were nonsignificant, and posttraining MFFT-summarization correlations were significant only for the trained groups, it appears that children who were reflective on the posttraining administration of the MFFT gained more from the summarization training than did their impulsive peers. Interestingly, this effect was not confined to the Executive condition; tempo also correlated with posttraining summarization within the Strategy condition. The correlation

between summarization scores and teacher ratings added an interesting twist: children judged impulsive in the classroom were poor summarizers within the Strategy and Control conditions, but not within the Executive condition. Evidently, some children who were rated by their teachers as impulsive were able to use the Executive instruction within the experimental setting, with a resulting change in summarization skills.

Tempo-metamemory correlations were nonsignificant both at pretest and posttest for fourth, fifth, and sixth graders. Furthermore, a oneway analysis of variance on metamemory scores confirmed that impulsive and reflective children did not differ from one another on metamemorial knowledge. Tempo-metamemory correlations for the earlier grades, using data from children who participated in both studies, were significant for children in the first and second grades, but not in the third, $r(27) = .324$, $r(30) = .336$, and $r(20) = .272$, respectively.

Stability of Constructs

Metamemory, pretest tempo, error, and latency scores were correlated with their equivalent scores from the earlier testing to determine the stability of the constructs across a three-year period. Correlations for the 77 subjects who participated in both studies are as follows: metamemory, $r = .333$; tempo, $r = .312$; errors, $r = .483$; and latency, $r = .286$.

Causal Modeling

A causal modeling procedure was used to assess the

developmental relationships among metamemory, tempo, and summarization strategies. Latent Variable Partial Least Squares (LVPLS) was used to estimate the model (Lohmöller, 1983; 1984). This exploratory "soft modeling" approach, which relies on a distribution-free least-square estimation procedure, was preferable to a confirmatory procedure such as LISREL because of the relatively small sample size. LVPLS aims only at consistency and is insensitive to impurities in the model and the data (cf. Wold, 1982).

The latent variables represented were Tempo at Time 1, Metamemory at Time 1, Tempo at Time 2, Metamemory at Time 2, and Strategy Use at Time 2. Tempo 1 was represented by MFFT error and latency scores from the earlier testing. Metamemory 1 was represented by summed, standardized scores from the four knowledge categories--elaboration, monitoring, task characteristics, and strategies. Tempo at Time 2 included MFFT errors and latency, and Conners scores. Metamemory at Time 2 was made up of the five metamemorial categories from the later testing: elaboration, monitoring, task characteristics, strategies, and study skills. Posttraining summarization scores from descriptive and explanatory paragraphs were used as the two measured variables representing Strategy Use. The analyses were conducted on data from the 73 children who participated in both studies. Four cases were omitted because of missing data.

Tempo and Metamemory at Time 1 were specified as the only exogenous variables, and were allowed to correlate with one another. It was assumed that the exogenous constructs

should influence Tempo, Metamemory, and Strategy Use at Time 2. In addition, it was expected that Metamemory and Tempo at Time 2 would predict Strategy Use, and that Tempo 2 would predict Metamemory 2. This model provided an acceptable fit to the data. Three path coefficients were less than .10 in the original model; these paths were fixed at zero, and a test of the new model showed that it did not differ appreciably from the original model.

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Insert Figure 1 about here

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Figure 1 shows the path diagram obtained for the final model, including the measurement model and the correlation between the latent exogenous factors. An important finding was the long-term connection between metamemory and strategy use: early metamemory predicted acquisition of reading summarization strategies three years later. Although Tempo at Time 2 predicted Strategy Use, Tempo at Time 1 was not a significant causal predictor. The results clearly show the importance of early metamemorial knowledge as a causal agent predicting later cognitive functioning. In addition to the path between Metamemory 1 and Strategy Use, early metamemory also had a direct impact on later metamemory and later tempo scores. In contrast, early Tempo was not a causal predictor of later Metamemory.

While the correlation between Tempo and Metamemory at Time 1 was moderately strong ($r$ = .46), this relationship disappeared at Time 2, when the correlation between the

latent factors Metamemory and Tempo was $r$ = -.03. Thus Metamemory and Tempo were correlated in the early elementary years, but not during the later years. Although data from the earlier study (Borkowski et al., 1983) indicated that the link between tempo and strategy use may be mediated by metamemory, data from this study showed a different pattern for the later elementary years: both Tempo and Metamemory were predictors of Strategy Use at Time 2, but Tempo and Metamemory were not correlated with one another, and no causal link between the two was supported by the modeling procedures.

Metamemory, Tempo, Strategies, and General Knowledge

Metamemorial knowledge is a subset of the general knowledge that a child possesses about his or her world. Knowledge as it is measured by standardized intelligence tests is usually an accurate predictor of children's performance on academic tasks. In order to examine the use of additional constructs, metamemory and cognitive tempo, in predicting performance on the summarization task beyond the predictive power of general knowledge, the effect of WISC scores was removed from the within-groups correlations between posttraining summarization and metamemory, and summarization and tempo. The summarization-metamemory correlation remained significant in the Executive condition, $r(48)$ = .285; the tempo-summarization correlation remained significant in the Strategy condition, $r(47)$ = .242, but not in the Executive condition.

Thus the relationship between prior metamemory and gains

in summarization skills due to Executive training remained when the effect of general knowledge was removed. Apparently, a child's metacognitive knowledge plays a role in determining treatment success above and beyond more traditional measures of intelligence.

## Discussion

Impulsive children have been shown to have both metacognitive and strategy deficits (Borkowski, Peck, Reid, & Kurtz, 1983; Douglas, 1980; Stober, 1985) including incomplete knowledge about strategies and their usefulness and inadequate executive processes necessary for strategy implementation. As new learning experiences enrich the knowledge base and expand strategy repertoires, the cognitive development of impulsive children lags behind that of their reflective peers. Furthermore, learning problems are magnified, with impulsive children exhibiting unique learning problems in areas such as reading and prose memorization.

It is against this background that three important findings emerged in the present study about the interplay among metamemory, cognitive tempo, and reading skills: (1) Causal modeling analyses support the contention that the relationships between metamemory and strategy acquisition are likely causal in nature (Borkowski et al., 1983; Kendall, Borkowski, & Cavanaugh, 1980; Kurtz et al., 1982). (2) As anticipated, early metamemory was shown to be a causal antecedent of cognitive tempo three years later. However, the tempo-metamemory relationship present in the first, second, and third grades was absent in the later elementary years.

(3) Children who received metacognitive instructions about executive skills in conjunction with strategy training became better summarizers than children who received only strategy training.

Metamemory and Cognitive Development

Brown (1978) and Flavell (1978) have posited a bidirectional hypothesis linking metamemory with strategic behavior. The first generation of research studies provided correlational support for the bidirectional hypothesis (e.g., Cavanaugh & Borkowski, 1980; Kendall, Borkowski, & Cavanaugh, 1980; Schneider, in press). Second generation research seeks a firmer base for establishing causal paths between memory and metamemory, and examines those paths in a variety of memory and metamemory domains. The present data provided support for causality between prior metamemorial knowledge about subordinate processes and later transfer of a newly-acquired summarization strategy, using a longitudinal design which allowed for multiple measurement of variables across time and a complex treatment package that included instructions about reading strategies and executive processes that might enhance the implementation of those strategies.

Results supported the hypothesis that prior knowledge about a wide variety of cognitive processes is a causal antecedent of a remote strategy (summarization), learned three years later. Although previous research has supported a proximal metamemory-memory relationship, the reported findings support a metamemory-memory link spanning time and knowledge domains. That is, a general measure of metacog-

nitive knowledge at an early age was shown to predict use of a specific strategy three years later in a new domain. Specific strategy knowledge was shown to be a causal antecedent of the later emergence of an unrelated strategy (cf. Pressley et al., 1985).

Early metamemory was also shown to have a causal impact on later tempo. Children who possessed accurate specific strategy knowledge in the early elementary years were more likely to be reflective three years later than were their metacognitively-impoverished peers. As well as lacking knowledge about how best to tackle problem-solving situations, these children likely did not recognize the value of a reflective response style. Years of non-strategic responding contribute further to an impulsive style.

An interesting developmental finding was the change in the metamemory-tempo relationship over time. Tempo and metamemory were correlated with one another in the early elementary years, yet the two were unrelated in the fourth, fifth, and sixth grades. Metacognitive knowledge in the early elementary years is likely determined by early parental enrichment, and dispositional characteristics of the child such as cognitive tempo. As the child proceeds through elementary school, metacognitive awareness is likely more and more a product of metacognitive instructional style of teachers, and first-hand experiences with learning and problem-solving situations (Hart, Leal, Burney, & Santulli, 1985). As the child encounters new sources of metacognitive knowledge in academic and nonacademic settings, cognitive

tempo becomes less closely related to the child's metacognitive skills.

Impulsivity, Reading Strategies, and Executive Instructions

An impulsive response style in the young child is associated with both social-behavioral problems and a failure to use efficient cognitive problem solving strategies (Borkowski et al., 1983; Douglas, Parry, Martin, & Garson, 1976; Kendall & Finch, 1979). The lack of a strategic problem solving approach puts impulsive children at a disadvantage academically. It is important to note, however, that both reflective and impulsive children in this study benefited from summarization and executive training. Although reflective children were better summarizers after training than impulsive children in all conditions, the lack of a Tempo x Training Condition interaction indicated that the beneficial effects of training were similar for both tempo groups. That is, both impulsive and reflective children who received executive instruction showed superior performance on a prose summarization task.

Forrest-Pressley and Gillies (1983) characterize reading as the flexible use of strategies, guided by metacognitive knowledge and monitoring processes. Some of the metacognitive skills involved in reading are clarifying the purposes of reading, focusing attention on the main content of the material, and monitoring comprehension (cf. Brown, in press). In general, younger and poorer readers exhibit metacognitive deficits such as viewing reading as a decoding process rather than a search for meaning, failure to recognize when a text

is ambiguous or incomplete, and a lack of sufficient study time and failure to recognize the need to modify strategies for texts of greater difficulty (Armbruster, Echols, & Brown, 1982; Baker & Brown, 1984; Brown & Smiley, 1978; Myers & Paris, 1978). The early metacognitive deficits of impulsive children may inhibit the development of good reading skills, creating a need for special instruction about executive processes.

A number of training studies have shown that the inclusion of feedback about the importance and potential applications of the instructed strategy--i.e., specific strategy knowledge--within training packages generally enhances strategy acquisition and transfer (e.g., Cavanaugh & Borkowski, 1979; Kennedy & Miller, 1976; Kestner & Borkowski, 1979; Paris, Newman, & McVey, 1982). More recent studies have attempted to increase children's understanding of executive skills such as monitoring, strategy selection, and strategy modification (Kurtz & Borkowski, 1984; Lodico, Ghatala, Levin, Pressley, & Bell, 1983). Lodico et al. trained children to monitor the utility of strategies, the affective consequences of strategies, or gave them no strategy-monitoring instruction. Children in the strategy-utility condition showed long-term maintenance of the effective strategy, abandoned an ineffective strategy at a relatively faster rate, and articulated metamemorial awareness. In a similar vein, training studies designed to alter self-control in young children have shown that information about monitoring and strategy use is an important determinant of the

scope of training success (Kendall & Wilcox, 1980; Schleser et al., 1981).

An example of the need for integrated training of strategy and executive processes in the context of reading strategy instruction can be found in recent studies by Palincsar and Brown (1984) and Paris and Jacobs (1984). Palincsar and Brown used a reciprocal teaching method which included metacognitive components to improve the reading comprehension of poor readers, resulting in sizeable gains in comprehension and transfer to new laboratory tasks. The successful treatment effects were replicated in an experiment using group intervention conducted by teacher volunteers. Paris and Jacobs gave children four months of classroom instruction on how, when, and why to use reading strategies. Posttraining analyses showed that the instruction increased children's reading awareness and their use of comprehension strategies such as rereading, anticipating, and paraphrasing. In these studies, however, metacognitive information about executive processes was integrated with training of lower-order strategies in experimental designs that did not allow the disentangling of those effects. Pressley, Forrest-Pressley, and Elliott-Faust (in press) have argued that componential analyses are needed to clarify the relative contributions of lower- and higher-level strategies to generalized performance gains. In this vein, the present data clearly implicate higher-level metacognitive skills as important factors in academic skill learning. That is, this study extended previous findings by demonstrating that information

about executive processes was a critical component in increasing the benefits of summarization strategy instruction for both reflective and impulsive children.

Although executive and strategy instruction improved the summarization skills of experimental children, no consistent changes were noted in tempo. Only fifth graders became more reflective on the Matching Familiar Figures test after executive training. No changes due to executive training were noted in teacher ratings of classroom behavior at any age. The superior summarization scores of children in the Executive condition, however, suggested that children of all ages may have become more reflective on that task. If tempo is task-specific as Baron (1981) suggests, improved summarization skills for children in the Executive group may have resulted from altered response styles. Unfortunately, latency data for the summarization task was not recorded. Had Executive training focused on picture matching in addition to reading and summarization strategies, significant changes might have been noted in performance on the Matching Familiar Figures, presumeably a more direct measure of impulsivity. Although training did not alter scores on the Matching Familiar Figures test, both impulsive and reflective children improved in summarization skills, with children who received metacognitive instruction showing the greatest improvement.

Perhaps the most important finding in this longitudinal study is the direct support for a causal link between early knowledge about subordinate processes and the later acquisition of summarization skills, especially if higher-level

metacognitive training is provided. What seems clear from this research is that reading programs aimed at prevention or remediation should not underestimate the impact of metacognitive deficiencies in attempting to produce generalized improvements. Training should take into account the quality of general metamemorial knowledge accumulated during the early school years, specific knowledge about the to-be-learned strategy, and knowledge about executive skills such as strategy implementation and monitoring. It is likely that the sequencing of complex training packages and their timing in relation to the child's academic history will prove critical in producing long-term gains in academic achievement.

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Table 1. Mean summarization scores at posttest adjusted for pretest summarization.

Impulsive

| | Grade 4 | 5 | 6 |
|---|---|---|---|
| Executive | 18.89 (3.52)* n = 8 | 23.31 (1.49) n = 8 | 21.12 (2.73) n = 6 |
| Strategy | 18.85 (2.74) n = 11 | 18.96 (4.14) n = 7 | 20.31 (4.34) n = 5 |
| Control | 15.58 (3.30) n = 4 | 16.58 (3.58) n = 5 | 21.73 (4.24) n = 2 |

Reflective

| | Grade 4 | 5 | 6 |
|---|---|---|---|
| Executive | 21.71 (2.49) n = 8 | 22.74 (2.33) n = 9 | 21.26 (3.70) n = 5 |
| Strategy | 20.44 (2.85) n = 9 | 20.77 (2.59) n = 8 | 20.82 (2.73) n = 6 |
| Control | 19.82 (2.61) n = 5 | 20.31 (2.61) n = 5 | 12.96 (9.90) n = 2 |

*Standard deviations appear in parenthesis.