International Journal of
Behavioral Development

http://jbd.sagepub.com

The Effects of Intelligence, Self-Concept, and Attributional Style on Metamemory and Memory Behaviour

Wolfgang Schneider, Joachim Kérkel and Franz Weinert

International Journal of Behavioral Development 1987; 10; 281

DOI: 10.1177/016502548701000302

INTERNATIONAL JOURNAL OF BEHAVIORAL DEVELOPMENT, 1987, *10* (3) 281–299

The Effects of Intelligence, Self-Concept, and Attributional Style on Metamemory and Memory Behaviour

Wolfgang Schneider, Joachim Körkel and Franz E. Weinert
Max Planck Institute for Psychological Research, Munich

The influence of intelligence, self-concept, and causal attributions on metamemory and the metamemory–memory behaviour relationship in grade-school children was studied. Following the assessment of intelligence, self-concept, and causal attributions, 150 children from each of grades 3 and 5 were given a metamemory interview and a sort-recall task. Metamemory, strategy, and recall scores increased with age. Causal modelling (LISREL) analyses using latent variables were conducted to assess the effects of the constructs intelligence and "hope of success" (i.e., the attributional and self-concept variables) on metamemory and memory behaviour. Hope of success significantly influenced metamemory and memory performance in the older children, but not in third graders. However, intelligence had an impact on metamemory in all age groups. But since metamemory still had a significant direct effect on memory behaviour, the study provides support for the assumption that metamemory remains an important predictor of memory behaviour even after the influence of conceptually related constructs has been taken into account.

INTRODUCTION

Research on the development of children's metamemory, that is, their knowledge about their own memory functioning and the memory system (Flavell & Wellman, 1977), has been stimulated by the assumption that metamemory plays a role in strategy development during the elementary school years. Although a stable and high correlation between metamemory and memory behaviour is not always to be expected (cf. Flavell, 1978; Weinert, in press), one of the most frequent arguments in favour of

---

Requests for reprints should be sent to Wolfgang Schneider, Max Planck Institute for Psychological Research, Leopoldstrasse 24, D-8000 Munich 40, F.R.G.

The authors wish to thank Beth Kurtz, Mike Pressley and Phil Winne for helpful comments on earlier drafts.

studying metamemory was that in general there should be a close relationship between metamemory and performance in various memory tasks.

Many earlier attempts to demonstrate causal linkages between metamemory and memory behaviour, however, were unsuccessful, particularly when organisational strategies in sort-recall tasks were investigated (Cavanaugh & Perlmutter, 1982). The unexpected results could have been due to two factors. First, metacognitive–cognitive linkages may be lower for pre-existing organisational strategies than for maintenance and transfer of newly learned and instructed strategies. In fact, a meta-analysis of the literature (Schneider, 1985) revealed that much stronger links between metamemory and use of organisational strategies were found in studies that included strategy training and a transfer paradigm. This may be because transfer requires a decision about whether to use or to abandon a previously learned strategy (cf. Borkowski, Reid, & Kurtz, 1984; Cavanaugh & Borkowski, 1980).

Second, poor assessment of metamemory in the earlier studies may have contributed to the disappointing results (Kurtz, Reid, Borkowski, & Cavanaugh, 1982). More recent investigations into the metamemory-memory behaviour relationship include more reliable metamemory assessment procedures and succeed in demonstrating important roles for metamemory in strategy acquisition, maintenance, and generalisation in sort-recall tasks (e.g. Borkowski, Peck, Reid & Kurtz, 1983; Kurtz & Borkowski, 1984). Undoubtedly, improving reliability of metamemory assessment techniques is necessary to establishing and proving construct validity. It is not sufficient, however. Metamemory is closely related to constructs like intelligence and self-concept, as well as variables tied more closely to personality and affect such as causal attributions, and cognitive style (see Borkowski, 1985; Flavell, in press). Given this conceptual overlap, the theoretical value of the metamemory construct depends on whether it still predicts memory behaviour and performance when its interrelationship with related cognitive and affective student characteristics has been taken into account. This hypothesis was tested in a few recent studies.

Borkowski et al. (1983) and Kurtz et al. (1982) found that the correlation between metamemory and strategy use remained significant when performance on an intelligence test was partialled out. More importantly, whereas metamemorial knowledge did predict subject's use of a previously trained learning strategy, I.Q. failed to predict strategy use on transfer tasks. Similarly, Borkowski et al. (1983) reported significant zero-order correlations among metamemory, I.Q. and impulsivity. However, the correlation between metamemory and use of a strategy with impulsivity partialled out remained significant, whereas the cognitive tempo-strategy use correlation was not significant when metamemory was removed. These findings support the discriminant validity of metamemory relative to intelligence and cognitive style, and with respect to performance.

With regard to causal attributions, different conceptualisations can be found in the metamemory literature. Causal attributions have been used as indicators of metamemory, that is, strategy knowledge (Fabricius & Hagen, 1984; Lodico et al. 1983). In Fabricius and Hagen's study, for example, subjects were asked what had affected their recall in a sort-recall task. Subjects' reference to category sorting strategies as a causal factor was used as an indicator of causal attribution and found to predict use of effective memory strategies. On the other hand, Kurtz and Borkowski (1984) referred to Weiner's (1980) general attributional model by assessing subjects' perceived causes for hypothetical outcomes via questionnaires. That is, the four perceived causes of success and failure (ability, effort, task difficulty, and luck) were comprised within two causal dimensions: locus of control (internal or external) and stability (fixed or variable). According to this classification scheme, ability is internal and stable, while effort is internal and variable. On the other hand, task difficulty is external and stable, whereas luck is both external and variable.

When analysing the effects of causal attributions on metamemory and strategy use, Kurtz and Borkowski found children who attributed success to controllable factors like effort both to be more strategic and higher in metamemory than those who attributed task outcomes to non-controllable factors like ability or task difficulty. However, no comparisons of the relative impact of causal attributions and metamemory on strategy use were reported in the aforementioned studies.

Taken together, all these studies confirm the assumption that metamemory, intelligence, causal attributions, and cognitive style are interrelated in that they show some overlap on the conceptual as well as operational level. But at the same time they provide some evidence that metamemory remains an important predictor of memory behaviour even when the impact of related constructs has been partialled out.

In the present study, a more conservative test was made of metamemory's independent impact on memory behaviour and performance. This study differed from those described above in three ways. First, uninstructed sort-recall learning was studied instead of maintenance and transfer following strategy teaching. Although the context of sort-recall learning did not prove favourable for the emergence of close metamemory–memory connections in earlier studies, we believed that a more reliable assessment of metamemory might be sufficient to reveal stable metamemory–memory behaviour relationships.

Second, the influence of theoretically competing concepts on the hypothesised relationships between metamemory and memory behaviour was assessed in this study by simultaneously considering the role of verbal and nonverbal intelligence, self-concept, and causal attributions. Specifically, these three constructs were included along with metamemory to build a structural model relating memory performance to all four variables. This approach should provide a much stronger test of the hypothesis that metamemory has an independent impact on memory behaviour and performance.

Third, a latent variable causal modelling approach (LISREL) was chosen to study the metamemory–memory relationship more adequately. Recent studies on the area (cf. Fabricius & Hagen, 1984; Paris, Newman, & McVey, 1982) have used causal modelling (path analysis) with manifest variables to describe and explain the role of metamemory in the prediction of strategic behaviour and recall. The approach used in the present study is an advance over these previous analyses in two respects. First, measurement error in observed variables is taken into account. Second, the structural (causal) relationships are analysed on the construct level and not on the level of manifest variables.

Sketch of the Study

In a first session, third and fifth graders were administered several intelligence tests along with questionnaires assessing their self-concept and causal attributions. In a second session, a metamemory interview was given, followed by a sort-recall task. In order to assess children's category sorting strategies, they were instructed to do anything with the stimuli that would help them to remember them better. After the sorting and study period, subjects first predicted the number of items that could be correctly recalled. This prediction reflects one aspect of memory monitoring and served as a second indicator of metamemory. Then, they recalled as many items as possible. Immediately after recall, subjects' ability to predict their recall for a future, highly similar sort-recall task was tested. Aspects of the children's memory behaviour, specifically, their sorting during study and clustering during recall, was assessed by calculating the adjusted ratio of clustering (ARC) scores developed by Roenker, Thompson, and Brown (1971). Sessions were separated by two week intervals.

METHOD

Subjects

Subjects were 150 children from each of grades 3 and 5 drawn from several elementary and high schools located in middle-class neighbourhoods in the area of Heidelberg, West Germany. There were approximately equal numbers of boys and girls in each grade. Mean ages were 9 years 2 months and 11 years 4 months for the third and fifth grade children, respectively. Testing was done in the middle of the school year.

Materials

Two subtests assessing verbal intelligence were selected from the Cognitive Abilities Test (Heller, Gaedicke, & Weinläder, 1976). The verbal comprehension subtest requires that subjects select a word out of five possible choices that corresponds most closely to an underlined keyword. In the word classification test, children were given three or four keywords that belonged in one category and were asked to choose one word out of five that would fit best into the same category as the keywords.

In addition, an assessment of nonverbal intelligence, the matrices subtest of the Culture Fair Intelligence Test (Cattell & Weiss, 1978), was given. For each of the 12 items children were instructed to identify which of five possible answers completed a geometric pattern.

Subjects' attributional style was assessed with a self-constructed questionnaire consisting of 16 items. Eight items referred to success situations; the other eight described failure situations. Half of the success and failure items related to classroom memory situations (e.g. "Imagine you did a spelling test and remembered all important spelling rules—why?") while the other half depicted memory in everyday life (e.g. "Imagine you have to do errands and manage to remember all items that you are supported to bring home"). One point was given for each internal (i.e. high ability or high effort) attribution concerning a success situation, and for every variable attribution (i.e. bad luck or low effort) relating to a failure situation. A sum score collapsed across situations was computed that, according to recent achievement motivation approaches (cf. Heckhausen, 1977, 1982), should reflect subjects' tendency towards success orientation.

Two operationally distinct self-concept scales were administered. A 20-item self-concept questionnaire assessed subjects' perceived competence in school and memory-related contexts. Subjects had to judge if the statements given were either true or not true for them. One point was given for each answer indicating a positive self-concept. In the second self-concept task, subjects were presented a sheet of paper with 30 schematic faces in a line from top to bottom of the page. It was explained that the faces represented the children in their class. The one at the top represented the child who did best at reading and so on to the worst performer. Besides reading, other academic (e.g. spelling, memory for texts) and non-academic (e.g. height, sports) items were included. For each item, a child's face on a bar graph was circled to represent relative position in the group. Scores ranged from 1 to 30, with a high score representing a positive self-concept (cf. Nicholls, 1978).

One part of the metamemory battery assessed general aspects of the metamemory (e.g. knowledge about text processing and about the difference between gist recall and rote recall of stories). It consisted of nine items that were modelled on those originally developed by Kreutzer, Leonard and Flavell (1975). Seven of these items were scored 1 point, the other two were worth 2 points. A task-specific component of metamemory was assessed by one additional complex item that assessed subjects' strategy preferences in a sort-recall task. A list of categorisable words was given in random order for this item, and the subjects had to rank-order six different study strategies with regard to their efficacy for learning the word list. Two of the strategies were not useful at all (e.g. looking at the short words first and then on the longer words). Two other strategies were of some help (e.g. rehearsing each word once). Finally, a grouping strategy and a cumulative rehearsal strategy were best. One point was awarded for correct classification of each strategy as useless, average, or good. Sum scores were computed for both the general and the task-specific component of metamemory. Maximum scores were 11 points and 6 points for the general and the task-specific components, respectively. In addition to subjects' verbalisable metamemory, memory monitoring was included as a third component of metamemory. Here, prediction accuracy concerning recall was assessed by taking the log of the ratio between prediction and recall. The absolute value of the log was used because the degree of under- or over-estimation was not a relevant issue.

In the "sort-recall for words" (Words) task, each child was given a magnetic board and a set of 24 words that were mounted on 1cm × 4cm magnetised cardboards. The words could be classified according to four categories (names, body parts, animals, professions) with six items in each category. The number of correctly recalled items served as an index of the subject's memory performance.

Procedure

All children were tested in groups of 15 to 20. In the first session, subjects received the intelligence tests, followed by the attributional style questionnaire and the two self-concept scales. In the second session, children were given the metamemory questionnaire. All items were read aloud to the children as they scanned the booklet.

In the Word task presented in the final session, each child was given a metal magnetic board and instructed that they had two minutes to arrange the words on the board in order to study them. They were told that another two minutes would be given for study and that they then would be asked to recall as many words as possible. Screens were used to prevent children from copying other's sorting of the words on the magnetic boards. After two minutes of study, the metal boards were collected and photographed in order to serve as a record of sorting behaviour. Thus cluster indices (ARC scores) could be obtained for both sorting during study and clustering during recall. Next, prediction and recall sheets were distributed. Subjects were first asked to predict how many words out of 24 they would be able to remember correctly. Then, the prediction sheets were collected, and the subjects were given three minutes for recall. After recall, a short questionnaire was given assessing children's strategies while sorting and studying the items. Subjects had to select those strategies out of a total of 11 strategies that they really used. Only four of these strategies (e.g. grouping, cumulative rehearsal) were useful in the context of sort-recall tasks, and one point was awarded for selection of any of these strategies. Next, a second estimate was made of the number of words each child might remember if given a similar, new set of 24 words to study, using the same procedure and length of study time.

RESULTS

Intelligence, Self-Concept, and Attributional Style

Mean scores and standard deviations for the various intelligence, self-concept, and attributional variables obtained in the two age groups are displayed in Table 1.

Multivariate analyses of variance (MANOVAs), followed by univariate ANOVAs, using grade level as the independent variable and the intelligence, self-concept, and attributional style variables as dependent variables revealed statistically significant age differences for all variables depicted in Table 1 (a significance level of $P < 0.05$ was used throughout this section; the cutoff F-value was 3.85).

Not surprisingly, fifth graders significantly outperformed third graders in all three intelligence subtests. Similarly, they significantly differed from

TABLE 1

Mean Scores for Intelligence, Self-concept, and Attributional Style Measures

Variables	*Grade 3*	*Grade 5*
Classification	13.32 (5.06)	15.17 (5.12)
Verbal comprehension	14.65 (5.66)	17.59 (5.21)
Matrices	6.57 (2.57)	7.55 (2.52)
Self-concept (verbal)	12.62 (3.32)	10.82 (3.15)
Self-concept (nonverbal)	13.54 (3.21)	10.71 (4.92)
Attributional style	2.61 (7.03)	6.87 (7.87)

[a]Standard deviations in parentheses

TABLE 2
Mean Scores for Metamemory, Memory Behaviour, and Memory Performance measures[a]

Variables	*Grade 3*	*Grade 5*
Task-specific Metamemory	3.49 (1.31)	3.90 (1.24)
General Metamemory	5.22 (1.59)	6.73 (1.34)
ARC Clustering (Sorting)	0.31 (0.45)	0.47 (0.43)
ARC Clustering (Recall)	0.29 (0.41)	0.54 (0.48)
Reported Strategies	2.13 (1.16)	2.89 (1.01)
Estimation Accuracy 1	0.17 (0.15)	0.16 (0.12)
Estimation Accuracy 2	0.16 (0.16)	0.12 (0.10)
Recall	10.51 (3.84)	15.00 (4.48)

[a]Standard deviations in parentheses

third graders in that they showed a lower, that is, more realistic self-concept and more success-orientation in the attributional scale.

Metamemory, Memory Behaviour, and Memory Performance

Means and standard deviations for all memory-related measures included in data analysis are given in Table 2, separately for each grade. MANOVAs using grade as the independent variable were performed separately for the two prediction, metamemory (general and task specific), strategy use (recall ARC, study ARC) and recall measures depicted in Table 2. With the exception of the first recall prediction, significant age differences were found for all dependent variables. Consistent with the literature, fifth graders showed higher metamemory, were more strategic in the sort-recall task and remembered more items than the younger children.

Causal Modelling using Latent Variables

The computer program LISREL VI (Jöreskog & Sörbom, 1984) was chosen to analyse the influence of I.Q., self-concept, and causal attributions on the metamemory–memory behaviour connection using the level of latent variables. LISREL consists of two parts: while the measurement model defines the relationship between observed variables and unmeasured hypothetical constructs, the structural equation model (i.e. "causal" model) is used to specify the causal links among the latent variables. Maximum likelihood estimates of measurement and causal parameters are obtained simultaneously; LISREL makes use of all information in the data about each parameter in generating its estimates. The efficiency of a given model is evaluated by a chi-square goodness-of-fit statistic which is a direct function of the discrepancy between the sample covariance matrix and that reproduced by the parameter estimates of the model. A large chi-square (relative to the degrees of freedom) indicates that the model does not provide a plausible representation of the causal process. Additionally, the so-called goodness-of-fit index (GFI) and the root mean square residual (RMR) can be used as measures of overall fit of the model. GFI is a measure of the relative amount of variances and covariances jointly accounted for by the model and should vary between zero and one (with higher scores indicating better fit). The root mean square residual RMR is a measure of the average of the residual variances and covariances. Here, acceptable model fit is indicated by values close to zero.

The measurement model was constructed as follows: the intelligence construct was represented by the three I.Q. subtests described above. The two self-concept scales and the attributional style questionnaire were taken to build up one single construct which was labelled "hope of success". According to Heckhausen's (1977, 1982) cognitive model of achievement motivation, the hope of success construct can be characterised as highly generalised expectancy of success, correlated with a realistic personal standard and a motivation-enhancing attribution pattern. As both the self-concept measures and the sum score computed for the causal attribution indicators reflect subjects' tendency toward success orientation, the factorial combination of these variables is thought to represent personality dispositions in the form of motive constructs described by Heckhausen. Metamemory was comprised of the two components described above (i.e. task-specific and general metamemory). The latent memory monitoring variable consisted of the two estimates of recall accuracy measures mentioned above. The memory behaviour construct consisted of the two clustering indices for sorting and recall as well as the children's strategy reports. The representation of the construct memory performance caused some problems because only one indicator (i.e. one recall measure) was available in the present study. Therefore, children's recall in the same sort-recall task given about 10 months later was chosen as a second performance indicator. An average correlation of $r = 0.65$ between the two recall measures was regarded sufficient to justify the inclusion of the second recall score in the measurement model.

The specification of the complete causal model chosen in the present study was determined by both the sequence of sessions and our knowledge about interrelations among the variables in question. As to the first aspect, the logic behind is that variables assessed earlier should influence subsequent variables. This does not mean, however, that a randomly chosen sequence of experimental sessions should dictate the nature of a causal model. The sequence chosen in the present study reflects our understanding of the interrelationship among the intelligence, motivational, and memory-related measures based on the literature.

Intelligence, self-concept, and causal attributions have been shown to affect metamemory and memory behaviour in earlier studies (e.g. Schneider, Borkowski, Kurtz, & Kerwin, in press). Similarly, these measures were thought to influence the memory-related measures in the present model. In accord with previous studies (Fabricius & Hagen, 1984; Paris et al., 1982), the causal model further specified that children's metamemory leads to strategic behaviours which in turn improve recall.

Thus the complete model specified that intelligence, self-concept, and causal attributions should influence subjects' verbalisable knowledge about memory (i.e. metamemory), which in turn should affect memory monitoring processes. Further, both components of metamemory (i.e. verbalisable knowledge and monitoring) are thought to influence strategic behaviour directly in the sort-recall task. Finally, metamemory as well as strategic behaviour should directly affect performance in the memory task.

As it is not clear from the literature how the relationship between intelligence and hope of success should be modelled, three different models were specified. In the first model (model A), intelligence and hope of success served as independent, exogeneous factors. This means that they were not further explained in this model. The only difference between this model and the two other specifications was that either intelligence was thought to influence hope of success (model B) or vice versa (model C). As a consequence, only one exogeneous factor was included in models B and C.

All three models were estimated and tested separately for the two age groups. All analyses to be described were based on covariance matrices. In both age groups, only model B (intelligence influences Hope of Success) yielded χ^2 values indicating acceptable data fit ($\chi^2 = 109.49$, df = 89 for third graders, $\chi^2 = 117.30$, df = 94 for fifth graders, P's > 0.05). The differences in χ^2 values among the three models within each age group form χ^2 statistics that can be used to test the importance of the parameters that differentiate the models. According to these comparisons, considerably better data fit was obtained for model B, compared to models A and C, regardless of age group. On the other hand, models A and C did not differ significantly from each other, irrespective of age. As a consequence, model B was chosen for further analyses.

It is one of the special advantages of the LISREL model that it can be used to analyse data from several groups simultaneously in order to test the degree of equality across covariance matrices of the observed variables. In the present study, three different simultaneous LISREL analyses were planned that represented tight, moderate, and loose model tests. According to Bentler (1980), a tight model test means that one attemps to fit the model to the second sample using the first sample's exact parameter estimates. In a moderate model test, some critical theoretical parameters are held constant but others can be estimated in the second sample. More specifically, the moderate model test of the present study required the estimates (factor loadings) produced by the measurement model to be invariant over groups and the remaining parameters to have the same pattern in both groups. The loose model test used in this study constrained all parameters of the measurement model and the structural model to have the same pattern across the two age groups.

We started with the loose model test to see if the same model holds for the two age groups. Unexpectedly, iterations did not converge. Thus, it was not possible to fit a single model to the data and, of course, there was no reason to continue with the moderate and tight model tests. Obviously, different structural equation models had to be assumed for the two age groups.

As a consequence, independent solutions were developed for each group. It should be noted that in a first step of analysis structural coefficients were estimated for all relationships. However, those coefficients close to zero were omitted in a second step without any loss of information. The LISREL solutions for third and fifth graders are given in Figs 1 and 2, respectively. Only the causal links (i.e. structural coefficients) among the six latent variables are included for the sake of clarity. The corresponding measurement models for the third and fifth graders are given in Tables 3 and 4, respectively. As can be seen from Figs 1 and 2, the various measures of goodness of fit indicated that the models fit the data. It should be noted that several alternative theoretical models were also

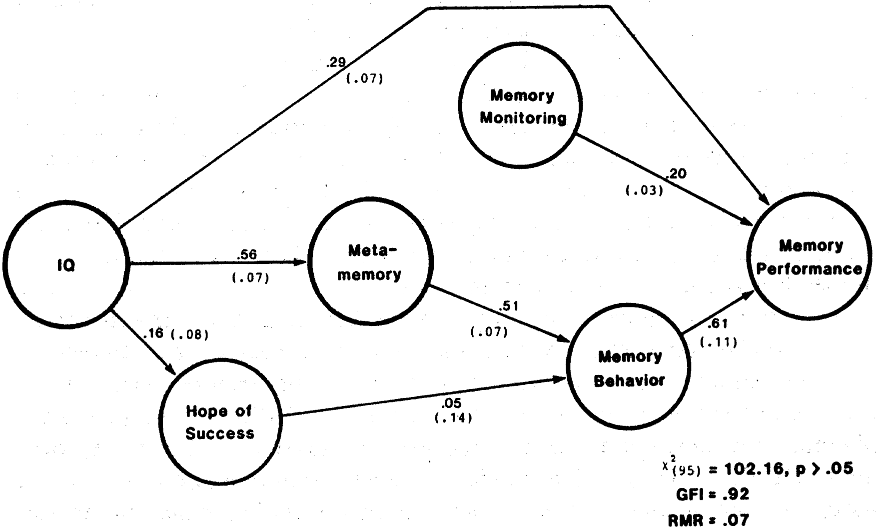

FIG. 1. LISREL model (structural model) explaining memory performance in third graders (standard errors of estimates in parentheses).

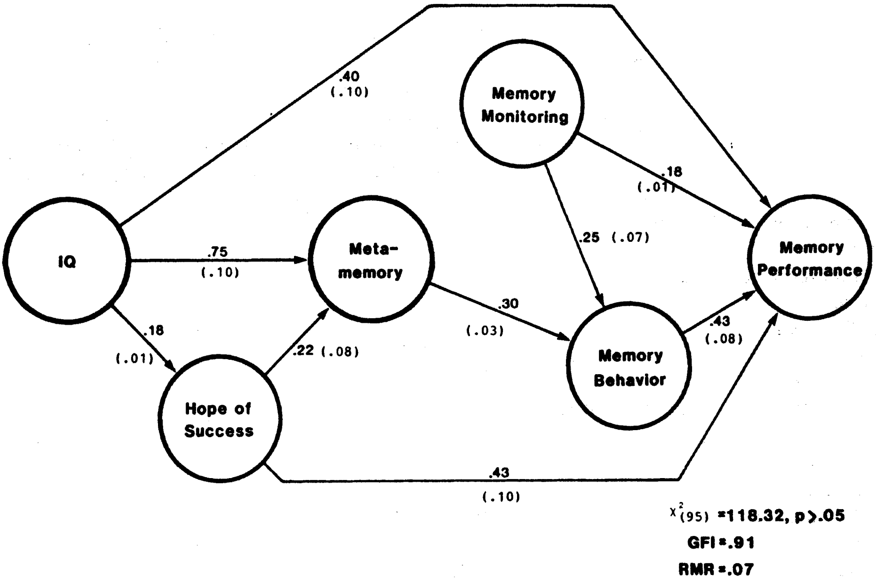

FIG. 2. LISREL model (structural model) explaining memory performance in fifth graders (standard errors of estimates in parentheses).

specified and tested to control for the possibility that different models fit the data equally well. For example, one model assumed that metamemory does not directly affect memory behaviour but influences memory performance; in another model, metamemory did not have any impact on memory behaviour and performance. As the model depicted in Figs 1 and 2 fit the data significantly better than the various alternative models, we decided to accept this model as the best description of the underlying causal process.

With regard to the central hypothesis of the present study, different results were obtained for the two age groups. Obviously, the impact of Hope of Success on memory-related measures was almost negligible in the younger children. In contrast, fifth graders' success orientation was directly related to metamemory and also significantly influenced the amount of recall in the sort-recall task. The second major difference between the two structural models concerned the role of memory monitoring (i.e. prediction accuracy): whereas memory monitoring affected recall in both age groups, it was only in the older age group that it also influenced memory behaviour. Somewhat surprisingly, memory monitoring was not significantly affected by the three preceding constructs (i.e. I.Q., hope of success, and metamemory), irrespective of age. As a consequence, the memory

TABLE 3
Measurement Model Estimates (Factor Loadings) for the Third Graders

	Construct					
Items	*I.Q.*	*Hope of Success*	*Meta-memory*	*Memory Monitoring*	*Memory Behaviour*	*Memory Performance*
Classification	1.00[a]					
Verbal Comprehension	0.57					
Matrices	0.45					
Attributional style		0.10				
Self-concept (Verbal)		0.16				
Self-concept (Nonverbal)		1.00				
Task-specific Metamemory			0.90			
General Metamemory			1.00			
Estimation Accuracy 1				0.83		
Estimation Accuracy 2				1.00		
Reported Strategies					0.83	
ARC Clustering (Recall)					1.00	
ARC Clustering (Sorting)					0.66	
Recall 1						1.00
Recall 2						0.73

[a] For each construct, one loading was fixed to one to secure that all constructs have the same measurement scale properties

monitoring construct represents a second exogenous factor in both LISREL models.

Similar structural patterns across age groups were found for the four remaining constructs: I.Q. had a strong direct impact on metamemory and a moderate effect on memory performance in both groups. Similarly, metamemory directly affected memory behaviour, which in turn influenced memory performance. Note, however, that the links among metamemory, memory behaviour, and performance were stronger for the third graders, compared with those for the fifth graders. Also, only an indirect impact of metamemory on memory performance was found in both age groups. As

TABLE 4
Measurement Model Estimates (Factor Loadings) for the Fifth Graders

	Construct					
Items	*I.Q.*	*Hope of Success*	*Meta-memory*	*Memory Monitoring*	*Memory Behaviour*	*Memory Performance*
Classification	1.00					
Verbal Comprehension	0.95					
Matrices	0.97					
Attributional Style		0.63				
Self-concept (Verbal)		0.67				
Self-concept (Nonverbal)		1.00				
Task-specific Metamemory			0.78			
General Metamemory			1.00			
Estimation Accuracy 1				1.00		
Estimation Accuracy 2				0.66		
Reported Strategies					0.79	
ARC Clustering (Recall)					0.92	
ARC Clustering (Sorting)					1.00	
Recall 1						1.00
Recall 2						0.64

can be seen from Table 5, this does not mean that metamemory is not correlated with memory performance. On the contrary, substantial zero order correlations resulted for both age groups. In our view, this example nicely demonstrates the advantages of more sophisticated structural equation modelling (e.g. LISREL, path analysis) over more traditional approaches (e.g. multiple regression analysis). The simultaneous estimation of structural relationships within the framework of LISREL makes it possible to differentiate between direct and indirect effects that may in fact differ considerably from their zero-order correlations. In our case the indirect effects of metamemory on memory performance were considerably lower (0.31 and 0.13 for third- and fifth-graders, respectively) than the zero-order correlations between the two constructs. Although the models fit the data in both age groups, the resulting disturbance terms

TABLE 5
Intercorrelations Among the Six Latent Factors Included in the Study[a]

Construct	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
(1) I.Q.	0.18 (0.18)	0.56 (0.79)	0.01 (0.00)	0.34 (0.24)	0.53 (0.58)
(2) Hope of Success		0.10 (0.35)	0.00 (0.00)	0.06 (0.11)	0.10 (0.55)
(3) Metamemory			0.01 (0.00)	0.56 (0.30)	0.53 (0.60)
(4) Memory Monitoring				0.00 (0.25)	0.18 (0.28)
(5) Memory Behaviour					0.72 (0.62)
(6) Memory Performance					— —

[a] Fifth graders' scores in parentheses

indicate that considerable amounts of variance remained unexplained for some constructs. This is particularly true for the memory behaviour construct: whereas 28% of its variance could be explained by the model specification for the third graders, only 15% of its variance was explained for the fifth graders. On the other hand, the structural models did explain a high proportion of the variance in the criterion variable (i.e. memory performance), namely 64% and 78% for third and fifth graders, respectively.

DISCUSSION

The results of the present study by and large corroborate the findings of Borkowski et al. (1983), Kurtz and Borkowski (1984), and Kurtz et al. (1982) in that metamemory had a significant impact on memory behaviour even after the effects of intelligence, self-concept, and causal attributions had been partialled out. This present data are notable because intelligence, self-concept, and attribution were simultaneously included as covariates, providing a stronger test of the hypothesis that metamemory does have an independent influence on memory behaviour and performance. That metamemory correlates with *free* recall learning, instead of the strategy training paradigm preferred in most other recent studies, demonstrates the robustness of the role of strategy knowledge in the development of memory. Previous studies using the free recall approach to assess metamemory—memory behaviour connections probably failed because of unreliable, poor metamemory assessments (see Rushton, Brainerd, & Pressley, 1983). In the present study, metamemory was tapped by a metamemory battery consisting of items that—at least in part—had already proven reliable in other studies (e.g., Borkowski et al., 1983; Kurtz et al., 1982). As a consequence, more substantial correlations were obtained for the metamemory–memory behaviour and performance relationship.

Although the present study indicates that the free recall paradigm can be used to demonstrate significant metamemory–memory behaviour relationships in elementary school children, the cross-sectional approach to the study of metamemory used here does not permit conclusions about the development, durability and generalisability of the metamemory–memory behaviour link. Strategy training approaches providing explicit metamemorial information, which are really short-term longitudinal studies appear much more promising (cf. Pressley, Borkowski & O'Sullivan, 1984). Here, pre-existing differences in metamemory can be controlled and separated from short-term training effects. Moreover, when subjects are provided new problems (i.e. transfer tasks), in training studies, generality of metamemory knowledge can be examined.

As to the developmental trends of the metamemory–memory behaviour relationship, the causal modelling procedure used here did suggest some new insights. Although significant mean differences between age groups were observed for most of the variables under investigation, differences in structural patterns identified for third and fifth graders were restricted to a few constructs. That is, although significant increases with age were observed for most of the variables included in the causal model, only a few interrelationships among the variables changed with age. In particular, the roles of the hope of success and memory monitoring constructs differed in the two age groups in that both were more important in predicting memory performance in the older children. These differences were big enough to prevent us from fitting one model to both grades. In particular, there were considerable differences between the two age groups on the factor loadings for the hope of success construct. Whereas high factor loadings were obtained for all self-concept and attributional measures in the fifth grade sample, hope of success was esssentially synonymous with non-verbal self-concept in third graders. The fact that the construct was not equally well represented in the two age groups may have at least partially contributed to the differing results.

The memory monitoring construct was included in the model to learn more about its validity in the different age groups. From a theoretical point of view, estimations of one's own recall can be influenced by one's standard of excellence, level of aspiration, and other motivational variables that may even replace memory monitoring processes. A closer look at Figs 1 and 2 reveals that this was obviously not the case. On the contrary, including a positive structural relationship between the hope of success and memory monitoring constructs resulted in a significantly worse data fit, regardless of age.

Another problem concerns the theoretical status of the memory monitoring construct. Estimation accuracy was assumed to reflect metacognitive processes in the case of significant relationship with the metamemory construct. As can be seen from Figs 1 and 2, there is no reason to assume that the memory monitoring construct does reflect metacognitive processes related to verbalisable metamemory for the third and fifth graders. From this, it can be concluded that the theoretical status of the prediction accuracy data remains questionable.

As to the differentiation between motivational and cognitive processes, a similar problem exists for the hope of success construct. Weinert (in press) points out that indicators of self-concept and causal attribution have been equally used in studies on metacognition and studies on motivational processes, but that they have different functions in motivational and metacognitive models. Given the predominantly low empirical relationship between the hope of success construct and the other latent variables, it is open to question if the construct has a more motivational or more cognitive flavour.

The generally low impact of self-concept and causal attributions on memory-related measures found for the younger children seems surprising, given the more positive results in studies mentioned earlier (e.g. Fabricius & Hagen, 1984; Kurtz & Borkowski, 1984). However, these data square well with recent findings by Schneider, Borkowski, Kurtz and Kerwin (1986). By comparing American and German subjects, Schneider et al. could show that attributional styles were directly linked to strategy use in American but not in German third graders. There is reason to assume that attributional styles may be culturally-linked. Results of a more recent study (Kurtz, Schneider, Turner & Carr, 1986) indicate that American parents teach attributional styles (effort attribution) much more than German parents do. Thus, the findings concerning the hope of success constructs may not be valid for American children.

With regard to the central hypothesis of the present study, however, results are in line with those of earlier American studies: the most important finding was that intelligence and—to a much lesser degree—the hope of success construct directly influenced task-specific and general metamemory, but that metamemory itself did have a substantial direct impact on memory behaviour and performance in third and fifth graders. Consequently, the results of the latent variable causal analyses appear to confirm the findings of Borkowski et al. (1983) based on manifest variables: metamemory maintained its direct influence on memory behaviour in children even after its relationship with conceptually related constructs had been taken into account. The generally positive empirical evidence found for the role of metamemory in the prediction of memory behaviour and performance should help validate this construct in theories of cognitive development.

Manuscript accepted 15 August 1986

REFERENCES

Bentler, P. M. (1980). Multivariate analysis with latent variables: Causal modeling. *Annual Review of Psychology*, *31*, 419–456.

Borkowski, J. G. (1985). Signs of intelligence: Strategy generalization and metacognition. In S. Yussen (Ed.), *The development of reflection*. New York: Academic Press.

Borkowski, J. G., Peck, V. A., Reid, M. K. & Kurtz, B. (1983). Impulsivity and strategy transfer: Metamemory as mediator. *Child Development*, *54*, 459–473.

Borkowski, J. G., Reid, M. K., & Kurtz, B. E. (1984). Metacognition and retardation: Paradigmatic, theoretical and applied perspectives. In R. Sperber, C. McCawley & P. Brooks (Eds), *Learning and cognition in the mentally retarded*. Baltimore: University Park Press.

Cattell, R. B. & Weiss, R. H. (1978). *Grundintelligenztest, Skala 2*. Braunschweig: Westermann.

Cavanaugh, J. C. & Borkowski, J. G. (1980). Searching for metamemory–memory connections: A developmental study. *Developmental Psychology*, *16*, 441–453.

Cavanaugh, J. C. & Perlmutter, M. (1982). Metamemory: A critical examination. *Child Development*, *53*, 11–28.

Fabricius, W. V. & Hagen, J. W. (1984). The use of causal attributions about recall performance to assess metamemory and predict strategic memory behaviour in young children. *Developmental Psychology*, *20*, 975–987.

Flavell, J. H. (1978). Metacognitive development. In J. M. Scandura and C. J. Brainerd (Eds), *Structural/process theories of complex human behaviour*. Alphen ad Rijn, Netherlands: Sijthoff and Noordhoff.

Flavell, J. H. (in press). Metacognition—Results, theoretical perspectives, and open questions. An overview of the state of the art. In F. E. Weinert & R. H. Kluwe (Eds), *Metacognition, motivation, and understanding*. Hillsdale, N.J.: Lawrence Erlbaum Associates Inc.

Flavell, J. H. & Wellman, H. M. (1977). Metamemory. In R. V. Kail & J. W. Hagen (Eds), *Perspectives on the development of memory and cognition*. Hillsdale, N.J.: Lawrence Erlbaum Associates Inc.

Heckhausen, H. (1977). Achievement motivation and its constructs: A cognitive model. *Motivation and Emotion*, *1*, 283–329.

Heckhausen, H. (1982). The development of achievement motivation. In W. W. Hartup (Ed.), *Review of child development research* (Vol. 6). Chicago: University of Chicago Press.

Heller, M. S., Gaedike, A.-K., & Weinläder, H. (1976). *Kognitiver Fähigkeitstest für 4.-13. Klassen (KFT 4-13)*. Weinheim: Beltz.

Jöreskog, K. G. & Sörbom, D. (1984). *LISREL VI: Analysis of linear structural relationships by maximum likelihood, instrumental variables, and least squares methods*. Mooresville, Indiana: Scientific Software.

Kreutzer, M. A., Leonard, C., & Flavell, J. H. (1975). An interview of children's knowledge about memory. *Monographs of the Society for Research in Child Development*, *40*, (1, Serial 159).

Kurtz, B. E. & Borkowski, J. G. (1984). Children's metacognition: Exploring relations between knowledge, process, and motivational variables. *Journal of Experimental Child Psychology*, *37*, 335–354.

Kurtz, B., Reid, M. K., Borkowski, J. G., & Cavanaugh, J. C. (1982). On the reliability and validity of children's metamemory. *Bulletin of the Psychonomic Society*, *19*, 137–140.

Kurtz, B., Schneider, W., Turner, L., & Carr, M. (1986). *Memory performance in German and American children: Differing roles of metacognitive and motivational variables*. Paper presented at the annual meetings of the American Educational Research Association, San Francisco.

Lodico, M. G., Ghatala, E. S., Levin, J. R., Pressley, M., & Bell, J. A. (1983). The effects of strategy monitoring training on children's selection of effective memory strategies. *Journal of Experimental Child Psychology*, *35*, 263–277.

Nicholls, J. G. (1978). The development of the concepts of effort and ability, perception of academic attainment, and the understanding that difficult tasks require more ability. *Child Development*, *49*, 800–814.

Paris, S. G., Newman, R. S., & McVey, K. A. (1982). Learning the functional significance of mnemonic actions: A microgenetic study of strategy acquisition. *Journal of Experimental Child Psychology*, *34*, 490–509.

Pressley, M., Borkowski, J. G., & O'Sullivan, J. T. (1984). Memory strategy instruction is made of this: Metamemory and durable strategy use. *Educational Psychologist*, *19*, 84–107.

Roenker, D. L., Thompson, C. P., & Brown, S. (1971). Comparison of measures for the estimation of clustering in free recall. *Psychological Bulletin*, *76*, 45–48.

Rushton, J. P., Brainerd, C. J., & Pressley, M. (1983). Behavioural development and construct validity: The principle of aggregation. *Psychological Bulletin*, *94*, 238–247.

Schneider, W. (1985). Developmental trends in the metamemory–memory behaviour relationship: An integrative review. In D. L. Forrest-Pressley, G. E. MacKinnon & T. G. Waller (Eds), *Cognition, metacognition, and human performance*, Vol. 1. New York: Academic Press.

Schneider, W., Borkowski, J. G., Kurtz, B. E., & Kerwin, K. (1986). Metamemory and motivation: A comparison of strategy use and performance in German and American children. *Journal of Cross-Cultural Psychology*, *17*, 315–336.

Weiner, B. (1980). *Human motivation*. New York: Holt, Rinehart, & Winston.

Weinert, F. E. (in press). Metacognition and motivation as determinants of the learning effectivity. In F. E. Weinert & R. H. Kluwe (Eds), *Metacognition, motivation, and understanding*. Hillsdale, N.J.: Lawrence Erlbaum Associates Inc.