15 Human Memory as a Faculty Versus Human Memory as a Set of Specific Abilities: Evidence from a Life-Span Approach

Monika Knopf
J. Körkel
W. Schneider
F. E. Weinert
Max Planck Institute for Psychological Research, Munich

INTRODUCTION

Since the very beginning of memory research in psychology, a most controversial issue has been the question if memory represents a general, unitary human faculty or rather a variety of specific and probably independent abilities. Everyday-life experiences lead us to believe that one can distinguish between people with a generally good memory who are able to remember various incidents and facts even after a long period of time, and those who easily forget whatever they have been told to keep in mind. On the other hand, pioneers of experimental research in memory like Ebbinghaus (1885) or Meumann (1907) already considered the possibility of extreme intraindividual differences in tasks covering different memory contents (e.g., assessing memory for prose versus memory for numbers). Meumann's position was not very clear, however; in his earlier studies (cf. Meumann 1907), he proposed a distinction between a "general memory" and several "task-specific memories," whereas he doubted the existence of a "general memory" in a later publication (Meumann, 1918), emphasizing the fact that—according to his empirical investigations—only special memories could be found.

A number of studies conducted in the 20s and 30s within the psychometric approach (e.g., Anastasi, 1932; Bolton, 1931; Lee, 1925) confirmed Meumann's (1918) later position in that only low correlations were found among memory tests varying either with regard to test materials (e.g., pictures versus words) or with regard to the type of assessment procedure (e.g., recognition versus recall).

In one of the most comprehensive investigations into the problem, Katzenberger (1964) tested 109 college students using 20 different memory tests which were systematically varied according to type of assessment (recall vs. recognition), test material (numbers, syllables, words, sentences, and pictures), and the time interval between task presentation and actual memory test (short- vs. long-term memory). The pattern of intercorrelations among his memory tasks corresponded to that found in the earlier studies, and a factor analysis computed on the intercorrelation matrix led to an eight-factor solution. Consequently, there was reason to conclude that the memory refers to a variety of different abilities or dimensions.

Within the psychometric approach, the most prominent hypothesis specifying developmental aspects of memory postulated the differentiation of special abilities during later childhood and early adulthood out of a fairly unified and general cognitive ability. For late adulthood the occurrence of de-differentiation was assumed (differentiation/de-differentation-hypothesis; Balinsky, 1941; Burt, 1954; Garrett, 1946). This hypothesis received empirical support in several studies (e.g., Friedman, 1974). Thus, in this research tradition the existence of relatively independent memory abilities was demonstrated at least for the age group of younger adults. On the other hand, a number of investigators have failed to find evidence for the validity of this hypothesis (summarized in Reinert, 1970).

The study of interindividual differences has been a traditional topic and issue of differential psychology. Within this discipline, it was claimed that most cognitive performances are likely immutable. Therefore performance tests were designed and test items were selected on which individuals maintained their relative position over time. Within the field of developmental psychology, however, individual differences have been neglected in favor of an emphasis on universal processes of development. This seems to be due to the predominance of the experimental model and the evolutionary approach in developmental psychology (McCall, 1977), treating individual differences as trivial, unstable variations that can have only little impact upon later development. Cronbach (1957) and others (e.g., Estes, 1974; Gagné, 1967) have commented on this lack of interest in more detail.

With the advent of information-processing models in the late 60s the conceptualization of memory changed essentially. In brief, the modal information-processing model specified three components of memory: structural features or hardware, the system architecture, and the programs or software (see e.g., Atkinson & Shiffrin, 1968; summarized in Campione, Brown, & Bryant, 1985; Hunt & Lansman, 1975). Whereas it was assumed that the structural features as well as the system architecture are relatively invariant components of the memory system, large individual differences were expected in the programable parts of the memory system both across subjects and within subjects. Psychologists interested in the question of intraindividual and interindividual differences began to search for tasks that require considerable strategic effort for effective execution. The idea was that the magnitude of performance differences between subjects as well as within subjects would be largest in strategy-intensive tasks (Brown, 1975).

A great deal of research in developmental psychology in the 70s and early 80s demonstrated that age-related changes in memory performance are in fact linked to the growing child's more frequent, spontaneous, and more flexible use of mnemonic strategies (cf. Brown, Bransford, Ferrara, & Campione, 1983; Hagen, Jongeward, & Kail, 1975). Finally, the concept of metamemory has been introduced by Flavell (1971; see also Flavell & Wellman, 1977) to explain even more of the performance differences in strategic memory tasks between and within subjects that could not be explained by memory strategies. On the other hand, it often was shown that developmental differences are hard to detect in such memory tasks where strategic activities are not efficient (cf. Perlmutter & Lange, 1978). In addition, developmental psychologists comparing memory behavior in retarded and nonretarded people (e.g., Campione & Brown, 1977, 1978) identified that strategy-intensive memory tasks do not only cause age-related differences in memory performance but also the most dramatic interindividual differences.

Further, the shift in theoretical conceptualization of memory stimulated new efforts in experimental psychology to analyze the magnitude and sources of interindividual performance differences. While psychometrics were mainly interested in differences at performance level, cognitive psychologists concentrated their interest on the identification of underlying psychological mechanisms and processes. Especially short-term memory processes became a fashionable and productive area of study (cf. Chase, Lyon, & Ericsson, 1981; Cohen, 1982; Humphreys, Lynch, Revelle, & Hall, 1983; Hunt, Frost, & Lunneborg, 1973; Kirby, 1980).

However, a review of the literature makes clear that only a few studies addressed the topic of the development of intraindividual patterns of memory performance. One line of research addressing this issue is strongly linked to the theoretical concepts and the techniques favored in the experimental approach to interindividual differences. Accordingly, the question has been to identify such memory processes that are causing interindividual variances as well as developmental differences in memory span tasks. Somewhat surprisingly, Dempster (1981) stresses that there is no conclusive evidence that any of the strategic memory processes (e.g., chunking, rehearsal, grouping) or the overall capacity of the system plays a role in interindividual memory span variance. By contrast, the investigations reviewed by Dempster suggest that the important factors underlying span differences are nonstrategic ones. Especially, the speed with which stimuli can be identified proved as a major source of both individual as well as developmental differences in memory span. Should these conclusions prove valid after further investigations it would be necessary to broaden the scope of memory tasks traditionally used in developmental psychology. Although Dempster (1981) does not explicitly address the question if memory should be treated as faculty or as a variety of specific abilities/skills, the rather low intraindividual correlations between different memory processes involved in memory span tasks are clear evidences for the second conceptualization.

In another line of research investigating the development of memory differences, the hypothesis was tested that interindividual differences in memory may reflect a general strategic factor. According to that assumption, some individuals may use memory strategies consistently and perform well, whereas others may use strategies poorly and thus remember inaccurately. For example, in a study by Kail (1979) 3rd- and 6th-graders were tested on three memory tasks. From each task, a strategy-free and a strategy-based measure was derived. The results of a factor analysis seemed to confirm the hypothesis, at least for the 6th-graders: here, all three strategy-based measures loaded heavily on one factor, which appeared to be the validation of the role of a general strategic factor. For the 3rd-graders, no such factor could be found. Although this finding suggests the existence of developmental changes in the interrelations among tasks, this cannot be inferred by a visual inspection of the intercorrelations among measures. Another problem with the interpretation of a general strategic factor is that this should correspond with highly significant correlations among the strategy-based measures. But as Kail (1979) pointed out, correlations, when significant, were rather small. Obviously, other factors must also have contributed to individual differences in 6th-graders' memory ability.

Stevenson, Hale, Klein, and Miller (1968) compared 3rd- through 7th-graders' performance on a series of learning and problem-solving tasks. As a main result, they found that correlations among the tasks were higher than those usually obtained, but that they were not, in the absolute sense, of high magnitude. The lowest intercorrelations were found for tasks that differed from one another both in structure and content. No notable developmental changes in the interrelations among tasks across the 5-year span of ages included in the study were detected. The authors concluded that their results offered little support for the operation of a general learning or memory factor.

So far, the most convincing evidence in favor of a general strategic factor and consistently high intertask correlations stems from a study by Cavanaugh and Borkowski (1980). The authors tested kindergarten children, 1st-, 3rd-, and 5th-graders by using three different memory tasks (i.e., cognitive cuing, free sort, alphabet search), and assessed the degree of consistency across the three tasks by computing intercorrelations among measures of study strategy, recall, and clustering during recall. A significant developmental improvement was found for almost all sets of intercorrelation with strategy measures showing particularly high intertask correlations in 1st-, 3rd-, and 5th-graders. Although these results seem to be very encouraging, it should be noted that only laboratory type tasks were used in the studies by Kail (1979) and Cavanaugh and Borkowski (1980).

Though these investigations on developmental aspects of memory differences produced an impressive body of interesting data, from a developmental point of view these studies suffer from some essential shortcomings. First, given the frequent criticism that laboratory studies have little relevance for understanding learning and memory processes as they occur in everyday life, we obviously need analysis of intertask consistency for memory tasks that differ with regard to structure, content, and the degree of ecological validity. Second, as the age range for subjects included in the studies is rather restricted, almost nothing is known about the consistency of memory performances over the life span.

In the following short-term longitudinal study, an attempt was made to reconsider the question of universal versus task-specific lines of memory development by enhancing the range of chronological ages included, by using a field-experimental approach to overcome problems related to small sample sizes, and by including memory tasks that differed with regard to content and structure, as well as to the degree of ecological validity.

The study focused on the problem of universal lines of memory development, that is, high intertask consistencies, can be demonstrated across the life-span when rather artificial, laboratory-type tasks as well as more natural, everyday memory tasks are simultaneously considered. A two-step procedure was chosen to test this assumption. First, interrelations among the different indicators were analyzed separately for each age group. As mentioned earlier, this has been the typical procedure to assess intertask consistencies. Given the predominantly low intercorrelations found in most of the previous studies, a second step of analysis was added that used a more liberal criterion of intertask consistency: Subjects were grouped into one of three categories according to their achievement (high, middle, low), separately for each task and age group. It was argued that universal lines of memory development may be claimed if high percentages of stable intertask classification of subjects can be found within each age group.

When the hypotheses of universal lines of memory development were not supported by both the more traditional and the more liberal tests, additional steps of analysis seemed appropriate to clarify the impact of strategy use and metacognition on memory performance in the various tasks. Intertask classifications of the various strategy and metacognition measures using the liberal criterion, already described should provide further information concerning the validity of a "general strategic factor" proposed by Kail 1979). Here again, a negative finding, that is, a lack of intertask consistency would justify the decision to concentrate on the analysis of task-specific lines of memory development. With negative cases, a final step of analysis should focus on the explanation of age-related changes in memory performance separately for each memory task by using measures of memory capacity, strategy use, and metamemory as covariates or possible explanatory concepts. This could give us a first estimate of the relative impact of memory capacity, strategy use, and metamemorial knowledge on performance in laboratory-type versus everyday memory tasks. More specifically, this kind of analysis could provide us with information concerning the degree of ecological validity involved in the laboratory-type tasks used in the present study.

METHOD

Our short-term longitudinal study was originally designed for different purposes (i.e., the analysis of the interaction among metacognition, attributional style, and self-instruction across the life span). Only those tasks and procedures relevant to the topic of universal versus task-specific lines of memory development are described below.

Samples: Two different samples were available for data analysis. The children sample consisted of 106 3rd-graders, 236 5th-graders, and 236 7th-graders. A total number of 124 adults and elderly people aged 50- to 84-years also participated in the study. This sample was subdivided into two age groups using the mean (63 years) as a classification criterion.

MATERIAL AND PROCEDURE

Memory Capacity

A digit-span task was used to assess memory capacity in children as well as adults. Subjects were instructed that the goal of the task was to assess one's own memory for telephone numbers. The procedure itself was similar to that used by Wechsler in his intelligence tests (the WISC and the WAIS).

Dependent measures: The maximum number of digits remembered in the correct serial order served as a measure of memory performance in this task for both children and adults.

Sort-recall Tasks

(a) Sort-recall task using nonclusterable stimuli: A total number of 24 word cards were used as stimuli. Words were selected in a way that made it very difficult to cluster or organize them in a meaningful way. Identical stimuli lists were used for children and adults. The children were given metal boards and asked to put the items on the boards. They were instructed to remember as many items as possible, and were free to move the stimulus cards on the board and do whatever they thought helpful for remembering the items. After a short study period, the boards were removed and subjects had to estimate how many items they could remember. Next, subjects had to recall the items. After that, they were asked again to estimate how many items they probably could remember in a similar, future task. The procedure for adults was slightly different in that no metal boards were used and the recall estimation tests were taken at different time points: The first estimate had to be given after a short word inspection period but before learning, whereas the second estimate followed the study and learning period immediately before recall.

Dependent measures: The number of items correctly recalled was used as a measure of memory performance. In addition, the absolute value of the second estimate divided by recall was taken as a measure of procedural metamemory. That is, accuracy of recall prediction was regarded as a measure of subjects' memory monitoring ability.

(b) Sort-recall task using taxonomically clusterable stimuli: Here, different stimulus lists were used for children and adults. The procedure was identical to that described above. Children were provided with 24 word cards with 6 items per category that could be categorized into four categories (animals, body parts, names, fruit), whereas adults were given 24 word cards that could be categorized into four subgroups of animals (birds, insects, exotic animals, and fishes).

Dependent measures: see above. In addition, clustering during study (i.e., sorting behavior) and clustering during recall were assessed by using the ARC-measure developed by Roenker, Thompson, and Brown (1971). Both measures were assumed to be indicators of strategy use.

(c) Sort-recall task using episodically clusterable stimuli (for adults only): A second clusterable list was constructed for the adult sample. Again, the subjects were given 24 word cards that could be categorized according to four episodes or actions (these were "writing a letter," "eating in a restaurant," "cleaning up a room," and "dressing").

Dependent measures: see above.

Everyday memory tasks (stories)

(a) Story about a soccer game: Different stories were constructed for children and adults. The story developed for the child sample consisted of 32 sentences and described a soccer game. It was constructed in a way that text comprehension was difficult for novices but relatively easy for experts. That is, the text required the reader to make several inferences in order to completely understand what was going on.

Children were told that they first had to listen to the story very carefully. After an (audio-taped) presentation of the story, subjects were given the story in a written format. They had another 5 minutes to read the story. After that, they were asked to underline those 10 sentences that they thought to be most important in order to understand the story. Next, a questionnaire was given assessing subjects' memory for details of the story as well as their correct inferences, and their awareness of contradictions or inconsistencies embedded in the text. Finally, they were presented with a quiz assessing their domain-specific knowledge concerning soccer.

Dependent measures: The number of details correctly remembered, the number of correct inferences, and the number of contradictions detected in the story were used as measures of memory performance. The importance-rating procedure (i.e., underlining of important sentences) was used as an indicator of strategy use. Further, the number of questions correctly answered on quiz procedure was taken as an indicator of domain-specific knowledge.

(b) Texts about a political topic: The adults were given six very difficult short texts with unfamiliar contents, addressing the United States Presidential Election campaign of 1980. After an intensive study period and repeated recall, subjects were presented with a 35-item questionnaire assessing their memory for details of the texts as well as their feeling-of-knowing judgments: The latter required a decision about whether the questions could be answered given the information provided by the texts; in fact, several questions could not be answered relying only on textual information.

Dependent measures: A sum score was computed for all those items of the questionnaire that dealt with informations given in the six texts. This score was the criterion for memory performance. The accuracy with which the subjects classified the items as answerable or not was regarded as an indicator of actualized metamemory. A sentence selection task (subjects had to indicate which sentences they thought to be most essential for the reproduction of the text) was used as a measure of strategic study behavior.

Metamemory

Different measures of metamemory were used for children and adults. (a) Metamemory assessment in children: Children's declarative metamemory was assessed using a comprehensive questionnaire including more than 40 items. The contents covered by the questionnaire included memory for prose, strategy knowledge concerning sort-recall tasks, and memory problems occurring in everyday life situations. Some of the items were taken from the Kreutzer, Leonard, & Flavell (1975) metamemory interview, but most of them were self-constructed. In addition, subjects were shown a sequence of slides that presented two children (a blue and a red one) who were instructed to do some shopping. The two models differed extremly with regard to the efficiency they demonstrated when doing the errands. Immediately after the slide series, subjects were given a questionnaire addressing their knowledge about efficient memory behavior in the shopping situation.

Dependent measures: The two components of declarative metamemory used in this study consisted of a sum score derived from the more general metamemory interview, and a sum score representing children's knowledge about memory in everyday life situations (i.e., the shopping situation). Procedural metamemory was assessed by the recall prediction measures used in the sort-recall task described earlier.

(b) Metamemory assessment in adults: Adults' declarative metamemory was assessed by using three self-constructed questionnaires. In a first questionnaire, we assessed subjects' knowledge concerning learning of numbers by asking for an evaluation of six different strategies that could be used for that purpose. In a second questionnaire, subjects were asked to indicate which strategies (out of a total of fourteen) seemed best suited to learn a list of isolated words. In a third questionnaire, they were asked to evaluate which strategies (out of fourteen) were best suited to learn and remember text materials. The rank-ordering of strategy efficacy used was based on the literature and further confirmed by an independent expert rating.

Dependent measures: The three different sum scores derived from the three metamemory measures were used as indicators of the quality of declarative metamemory knowledge in elderly adults. In addition, three measures assessing accuracy of recall estimates for the nonclusterable, taxonomically clusterable, and episodically clusterable word lists described above were used as indicators of procedural metamemory. Furthermore, knowledge about the availability of required information, that is, the feeling-of-knowing judgments, were regarded as a measure of memory monitoring.

RESULTS

1. The development of different aspects of memory performance across the life-span. Means and standard deviations for all memory performance measures (separately for each age group) are given in Table 15.1. With regard to the child sample, highly significant age differences were found for all measures included. With regard to four of the six performance measures included in the analysis, all age groups differed from each other, whereas for the remaining two measures (i.e., memory span and episodic memory for texts) the 3rd-graders recalled significantly less than the older age groups who did not differ from each other. On the other hand, significant differences between the two elderly adult samples could only be detected for two measures (i.e., recall for the nonclusterable word list and recall for the episodically clusterable list, which was always superior for the younger of the two age groups). Although it should be emphasized that the data stem from cross-sectional analyses, a quasi-longitudinal view across the life span (although leaving out most of the age range of adolescence and adulthood) seems particularly interesting for the memory span task und the sort-recall task using nonclusterable words because these two tasks were directly comparable for all age groups. From Table 15.1, it seems that there is no difference between 7th graders' and adults' average memory span. On the other

TABLE 15.1
Means and Standard Deviations (in Parentheses) for the Memory Performance Measures, Separately for Children and Adults

	Age Groups				
	Children			Elderly Adults	
Measures	3rd Grades	5th Grades	7th Grades	$\bar{x}_a \leq 63$	$\bar{x}_a > 63$
Memory Span	$5.10^{B,a}$ (1.18)	5.33^{B} (1.10)	6.10^{A} (1.12)	6.10 (1.05)	6.02 (1.14)
Recall Nonclusterable List	7.65^{C} (2.76)	12.32^{B} (3.94)	13.68^{A} (4.29)	14.54^{*b} (4.23)	12.43 (4.53)
Recall Clusterable List	10.41^{C} (3.91)	15.54^{B} (4.18)	17.42^{A} (4.44)	18.30 (3.85)	17.36 (3.47)
Recall Episodic Clusterable List				19.85* (3.99)	16.65 (4.56)
Text Inferences	1.44^{C} (1.30)	4.00^{B} (2.06)	4.58^{A} (2.20)		
Text Episodic Memory	2.06^{B} (0.61)	2.43^{A} (0.68)	2.54^{A} (0.63)		
Text Contradictions	0.11^{C} (0.32)	0.72^{B} (0.73)	1.03^{A} (0.81)		
Text Questionnaire				10.58 (4.52)	10.21 4.15)

[a] In each row, different capital letters indicate significant group differences for the child sample (i.e., A>B>C).
[b] Similarly, the asterisk indicates significant group differences for the adult sample.

hand, the younger age group within the sample of elderly adults did outperform 7th-graders with regard to recall for the nonclusterable word list. Interestingly enough, average recall of the older subsample was remarkably lower and, by and large, comparable to that of 5th-graders in this type of task. Because these results are based on a cross-sectional design, they can only give us a hint about the idea, that the ability to manage highly strategic learning in memory tasks is decreasing beyond the age of sixty already.

Means and standard deviations of the strategy and metamemory measures are given in Table 15.2 to complete the pattern of results. The developmental trends found for the memory performance measures were replicated for the strategy use and metamemory measures. With regard to the children, significant increases with age were found for all measures. Planned post-hoc comparisons revealed that most age-related differences occured between 3rd- and 5th-graders. It was only for the general metamemory measure and the importance rating procedure that all age groups differed significantly from each other. On the other hand, no significant differences were found between the two subsamples of elderly adults.

2. Age-related patterns of memory performances. In a further step of analysis, intertask correlations for the various memory performance measures were computed based on the total child sample. As can be seen from Table 15.3, most of the intercorrelations were relatively small in magnitude, especially when relationships among measures derived from different types of tasks were considered. Although all correlations depicted in Table 15.3 were statistically significant (due to large sample size), only the correlation between the recall measures

TABLE 15.2
Means and Standard Deviations (in Parentheses) for the Strategy Measures, Measures of Metamemory, and Domain-Specific Knowledge, Separately for Children and Elderly Adults

	Age Groups				
	Children			Elderly Adults	
Measures	3rd Graders	5th Graders	7th Graders	$\bar{x}_a \leq 63$	$\bar{x}_a > 63$
Clustering during sorting (RCL)	0.34[B,a] (0.46)	0.50[A] (0.40)	0.55[A] (0.48)		
Clustering during recall (RCL)	0.31[B] (0.42)	0.55[A] (0.45)	0.56[A] (0.46)	0.85 (0.24)	0.84 (0.22)
Clustering during recall (ECL)				0.94 (0.10)	0.91 (0.22)
Importance rating/ sentence selection task	2.94[C] (1.53)	4.63[B] (1.37)	5.61[A] (1.46)	6.9 (2.0)	6.3 (1.8)
Accuracy of recall estimate (NCL)	0.30[B] (0.32)	0.19[A] (0.19)	0.17[A] (0.20)	0.35 (0.33)	0.40 (0.47)
Accuracy of recall estimate (RCL)	0.36[B] (0.32)	0.25[A] (0.22)	0.22[A] (0.19)	0.24 (0.39)	0.32 (0.29)
Accuracy of recall (ECL)				0.59 (0.26)	0.45 (0.35)
Feeling-of-knowing judgments				22.81 (3.60)	22.04 (3.35)
General metamemory	12.21[C] (2.65)	14.03[B] (2.37)	14.78[A] (2.21)		
Everyday-life memory knowledge	7.38[B] (1.65)	8.07[A] (1.74)	8.33[A] (1.79)		
Strategy knowledge numbers				3.4 (1.32)	2.8 (1.30)
Strategy knowledge words				3.86 (6.05)	5.05 (5.83)
Strategy knowledge text				11.85 (1.42)	11.54 (1.52)
Domain-specific text knowledge	5.24 (2.07)	7.49 (2.29)	7.90 (2.03)	1.24 (1.15)	1.28 (1.32)

[a]In each row, different capital letters indicate significant group differences for the child sample (i.e., A<B<C).

TABLE 15.3
Intertask Correlations for Memory Performance Measures (Child Sample, N = 578)

Memory Performance Measures	Recall Noncluster-able List 2	Recall Cluster-able List 3	Text Infer-ences 4	Text Episodic Memory 5	Text Contra-dictions 6
1. Memory Span	.24*	.29	.12	.10	.16
2. Recall Non-clusterable List		.66	.30	.19	.34
3. Recall Clusterable List			.29	.25	.41
4. Text Inferences				.36	.44
5. Text Episodic Memory					.40

* All correlations are significant ($p < .05$)

of the two word lists was numerically high enough to indicate high intertask consistency. When intertask correlations were computed separately for each age group (cf. Table 15.4), magnitude of correlation coefficients decreased for all performance measures. Again, only the correlations between the two sort-recall lists were high enough in magnitude to represent sufficient intertask consistency. Interestingly, no clear developmental trend could be detected across the various memory measures. A different pattern of results was found when intercorrelations among memory performance measures were analyzed for the elderly adult sample. Although the structure of intercorrelations was quite similar to that found for the total child sample (cf. Table 15.5) in that the highest intertask consistency was found for the different sort-recall tasks used, the intercorrelations done for all measures separately for each age group clearly showed a developmental trend (cf. Table 15.6). For almost all measures except for the memory span tasks, more substantial correlations were obtained for the younger subsample of elderly adults, thus indicating a decrease of intertask consistency over the years. It should be noted that intercorrelations obtained for the younger subsample of elderly adults were considerably higher than those calculated for the total sample. Apparently, the assumption of a unitary memory ability or high intertask consistency—even between measures of memory tasks differing in content and structure—could be at least partly confirmed for this specific subsample.

But as this was not true for the remaining age groups, a second step of analysis was entered that focused on a more liberal criterion of intertask consistency. That is, subjects were classified as high (best 25%), medium (50%), or low (lowest 25%) achievers separately for every memory task. As can be seen from Table 15.7, percentages of children and adults consistently classified as

TABLE 15.4
Intertask Correlations for Memory Performance Measures, Separately for Third Graders (Upper Row), Fifth Graders (Middle Row), and Seventh Graders (Lower Row)

Memory Performance Measures	Recall Noncluster-able List 2	Recall Cluster-able List 3	Text Infer-ences 4	Text Episodic Memory 5	Text Contra-dictions 6
1. Memory Span	.01	.26*	-.10	.15	-.13
	.07	.17	.08	.00	.13
	.21*	.15	.07	.02	.01
2. Recall Non-clusterable List		.43*	.01	.06	-.01
		.50*	.17	.07	.17
		.62*	.00	.10	.21*
3. Recall Clusterable List			.01	.13	.09
			.10	.08	.18
			.03	.21*	.34*
4. Text Infer-ences				.18	.13
				.34*	.30*
				.24*	.32*
5. Text Epi-sodic Memory					.31*
					.34*
					.34*

Note: Asterisks denote significant correlations ($p < .05$)

high, medium, or low achievers across various combinations of memory tasks were calculated next. As a result, it was found that, again, intertask consistencies were highest for the sort-recall tasks, irrespective of age. In addition, no developmental trends were detected for the laboratory-type tasks for the children, whereas the proportion of consistent classifications in this age group increased with age for the text measures. Finally, and probably most importantly, the number of consistent classifications in the different age groups dropped considerably when measures from memory tasks differing in contents and structure were combined. Somewhat surprisingly, high percentages of intertask consistency could not be detected even when using a more liberal criterion. Given the fact that there has been some empirical evidence in the literature supporting the hypothesis of a ''general strategic factor,'' similar analyses were conducted for the strategy and the metamemory measures to find out if different patterns of consistency across measures could be detected for these variables. But as can be seen from Table 15.8, decreases in the number of consistently classified subjects similar to those observed for the memory performance measures were found when all strategy measures or all metamemory measures were considered simultaneously. This finding sheds doubt on the assumption that concepts like a ''general strategic factor'' (Kail, 1979) or subgroups of ''metamnemonically sophisticated subjects'' (Flavell, 1981) can be empirically identified.

TABLE 15.5
Intertask Correlations for Memory Performance Measures (Adult Sample, N = 124)

Memory Performance Measures	Recall Noncluster-able List 2	Recall Taxon. Clusterable List 3	Recall Episodic Cluster-able List 4	Text Question-naire 5	Text Free Recall 6
1. Memory Span	-.13	.09	-.04	.05	.13
2. Recall Non-clusterable List		.44*	.60*	.27*	.33*
3. Recall Taxon. Clusterable List			.58*	.31*	-.03
4. Recall Episodic Cluster-able List				.29*	.28*
5. Text Questionnaire					.29*

Note: Asterisks indicate significant intertask correlations ($p<.05$)

3. The stability of memory performances and metamemory measures. In order to complement these findings based on cross-sectional data, we additionally looked at retest stability information that was available for some of the memory performance, strategy use, and metamemory measures. As can be seen from Table 15.9, the percentage of children consistently classified as high, medium, or low in achievement about 1 year later was quite comparable across

TABLE 15.6
Intertask Correlations for Memory Performance Measures Separately for the Younger Age Group (Upper Row) and the Older Age Group

Memory Performance Measures	Recall Noncluster-able List 2	Recall Taxon. Clusterable List 3	Recall Episodic Cluster-able List 4	Text Question-naire 5	Text Free Recall 6
1. Memory Span	-.16 -.13	-.02 .15	-.01 .12	-.10 -.05	 .17
2. Recall Non-clusterable List		.59* .19	.63* .48*	.25* .30*	 .47*
3. Recall Taxon. Clusterable List			.64* .44*	.43* .08	 -.05
4. Recall Episodic Cluster-able List				.32* .31*	 .41*
5. Text Questionnaire					.37*

Note: Asterisks denote significant correlations ($p<.05$)

TABLE 15.7
Percentage of Subjects Consistently Classified at High, Medium, or Low in Achievement for Various Combinations of Memory Tasks

	Age Groups			
	Children			Elderly Adults
Measures	3rd Graders	5th Graders	7th Graders	$\bar{x}_a = 63.1$
Nonclusterable and taxon. clusterable lists	50	56	64	55
Nonclusterable and episodic clusterable lists				59
Two clusterable lists				45
Word lists and memory span	24	21	24	15
Text inferences and Text episodic memory	39	44	39	14% lower group[a] 28% middle group 5% upper group
Text inferences and Text contradictions	31	44	49	
Text episodic memory and contradictions	19	31	39	
All three text variables	4	17	22	
All text variables and memory span	2	7	7	
All word list variables and all text variables	0	4	7	
All word list variables and all text variables and memory span	0	2	2	7% lower group[a] 51% middle group 13% upper group

[a]We changed the classification criterion in the adult sample because of missing data. A person was classified as "consistent" in the lower, middle, or upper group when she has this position in at least 3 (out of 5) performance measures. Further, this analysis was done for the combined adult sample (N=124; $\bar{x}_{age}$=63.1 years).

the different age groups. It should be noted that the *true* proportion of consistent subjects is probably underestimated because standard error of measurements had not been taken into account. Therefore, the estimates of retest-stability we got from these analyses seemed, by and large, acceptable.

4. The impact of memory related variables on memory performance. Nonetheless, the results of the correlational and classification analyses leads one to assume that a unitary memory function cannot be identified. Therefore, a final step of analysis concentrated on task-specific performance differences among age-groups and the role that measures of memory capacity, memory strategy, and metamemory can play in explaining age-related performance differences. This procedure should be likely to answer the questions if subjects' memory

TABLE 15.8
Percentage of Subjects Consistently Classified as High, Medium, or Low in Achievement for Various Combinations of Strategy and Metamemory Measures

	Age Groups			
	Children			Elderly Adults
Measures	3rd Graders	5th Graders	7th Graders	$\bar{x}_a = 63.1$
Clustering during sorting and during recall	48	61	67	
Importance rating and clustering during sorting	36	36	36	
Importance rating and clustering during recall	34	36	37	37
Importance rating and all cluster measure	16	21	25	
2 accuracy of recall estimates (NCL + RCL)	40	37	36	35
All three accuracy of recall estimates				0
General metamemory and everyday-life memory knowledge	38	37	37	
2 accuracy of recall estimates and 2 general metamemory measures	8	9	6	
All three accuracy of recall estimates and feeling-of-knowing judgment and strategy knowledge numbers				0% lower group[a] 40% middle group 0% upper group

[a]We changed the classification criterion because of missing data. A person was classified as "consistent" in the lower, middle, or upper group when she kept this position in at least 3 (out of 5) metamemory measures. Further, this analysis was done for the combined adult sample (N=124).

capacity, strategy knowledge, strategy use, and domain specific knowledge have a different impact on their performance in different memory tasks.

A series of ANCOVAs was run in order to assess the relative impact of each covariate on age-related differences in memory performance as well as the combined, simultaneous effect of all covariates on age-related memory improvement. Table 15.10 gives an overview of results obtained for the child sample. The age effects on performance differences (F-values) obtained for a series of ANCOVAs are given in the upper row of the table.

For all covariates listed below, the reduced F-value for grade effect caused by their inclusion into the equation is given first, followed by F-values (in parentheses) indicating their importance for the dependent memory measure in question. A comparison of the first and the last row gives a first impression of the combined impact of all covariates on age-related changes in memory performance: that is, the last row shows the attenuated effect (F-value) of grade on memory performance.

With regard to the two recall measures for clusterable and nonclusterable items, the drop in age-effects caused by the combined inclusion of all relevant covariates is remarkable, although the attenuated F-values still remain significant. This finding indicates that the covariates included cannot account for all age-related changes in memory performance. When the separate effects of the covariates are considered, it appears that all of them are comparably high for the nonclusterable list, but that the two strategy variables, that is, clustering during sorting and clustering during recall, had by far the most substantial effect on recall for clusterable lists. It should be noted however, that—with the exception of the memory monitoring measure (accuracy of recall estimate)—indicators of memory capacity as well as indicators of general metamemory had also significant effects on the memory performance measure.

Results are even more impressive when the three text variables are considered. Here, the impact of combined covariates was substituted for all memory performance measures, as can be seen from the dramatically decreased grade effect on performance. In the case of episodic text memory, the simultaneous inclusion of all covariates resulted in a complete elimination of age-related effects. Here, the importance of preexisting domain-specific knowledge, that is, experience with the soccer game, was mainly responsible for the impressive result. This covariate did contribute most to the prediction of performance for all three dependent text measures. But here again, also indicators of strategy use and general metamemory had significant impact on memory for text, whereas the measure of memory capacity proved to be meaningless with regard to this dependent variable.

A similar series of analyses was also done for the elderly adult sample (cf.

TABLE 15.9
Percentage of Subjects Consistently Classified as High, Medium, or Low in Achievement for Selected Memory Tasks Applied Twice Within the Period of One Year (N = 315; Short-Term Longitudinal Study)

	Grades		
Measures	3rd-/4th-Graders	5th-/6th-Graders	7th-/8th-Graders
General metamemory	48	45	49
Importance rating	47	45	40
Recall NCL	55	57	56
Recall RCL	52	42	57
Memory span	50	51	41
Accuracy NCL	42	39	43
Accuracy RCL	30	36	34
Clustering during recall	41	31	61
Clustering during sorting	45	43	41

TABLE 15.10
Results (F-Values) of a Series of ANCOVAs Computed to Assess the Effects of Different Covariates on Age-Related Changes in Children's Memory Performance

Effect of Grade and Covariates	Dependent Measures: Recall Noncluster-able List	Recall Cluster-able List	Text Infer-ences	Text Episodic Memory	Text Contra-dictions
Grade	88.27	100.08	91.51	20.55	62.42
Memory Span	73.19 (9.28)*	79.54 (18.53)*	86.19 (0.08)	17.73 (0.63)	53.95 (0.74)
Clustering during sorting		86.75 (85.33)*			
Clustering during Recall		85.79 (132.43)*			
Accuracy of Recall estimate (NCL)	77.36 (10.35)*				
Accuracy of Recall estimate (RCL)		92.64 (0.96)*			
Importance Rating			33.21 (54.02)*	4.59 (21.43)*	20.13 (34.34)
Domain-specific knowledge			34.60 (231.31)*	4.40 (61.08)*	25.52 (107.47)*
General metamemory	64.50 (9.86)*	63.38 (23.40)*			
Everyday-life memory knowledge	77.62 (15.45)*	87.03 (29.47)*	84.60 (2.39)*	17.53 (5.86)*	55.50 (6.63)*
Simultaneous inclusion of all relevant cova-riates	41.94	41.67	18.41	0.03	7.79

Numbers in parentheses indicate F-values for the covariates in question.

Table 15.11). Of course, as the age group effect on memory performance was relatively small for most dependent measures considered in the analysis, no strong covariate effects could be expected for this sample. Not surprisingly, the simultaneous inclusion of all covariates resulted in nonsignificant attenuated age effects on all dependent measures. Again, memory span did not show any important influences on memory performance in the sort-recall tasks and the text measure used. The most substantial effects were obtained for the memory monitoring measure (feeling-of-knowing judgments) and the domain-specific knowledge measure used to predict performance in the memory for prose task. The significant impact of domain-specific knowledge was somewhat surprising because of the generally low level of preexisting knowledge in most elderly subjects. Obviously, already small differences in domain-specific knowledge proved sufficient to significantly influence recall.

GENERAL DISCUSSION

In our view, the results of the present study do add some information to the issue of unitary versus task-specific lines of memory development. First of all, the analysis of intertask correlations yielded different findings for children and elderly adults. Intertask correlations were generally low for the three child samples

TABLE 15.11

Results (F-Values) of a Series of ANCOVAs Computed to Assess the Effects of Different Covariates on Age-Related Changes in Elderly Adult's Memory Performance

Effect of Grand and Covariates	Dependent Measures: Recall Noncluster-able List	Recall Taxon. Clusterable List	Recall Episodic Cluster-able List	Text Question-naire
Age Group	7.07*	1.79	11.29*	0.19
Memory Span	7.59 (2.54)	1.65 (0.24)	11.13 (0.34)	0.21 (0.18)
Clustering during Recall (RCL)	3.85 (0.91)	1.61* (9.48)		
Clustering during Recall			10.58 (1.33)	
Accuracy of Recall estimate (NCL)	2.57 (12.72)*			
Accuracy of Recall estimate (RCL)		1.69 (2.35)		
Accuracy of Recall estimate (ECL)			0.86 (0.00)	
Sentence Selection Task				0.25 (7.17)*
Feeling-of-Knowing Judgments				0.05 (48.78)*
Strategy Knowledge Words	7.93 (9.15)*	1.71 (1.96)	13.29 (2.66)	
Strategy Knowledge Texts				0.55 (0.89)
Domain-specific Knowledge				0.31 (17.31)*
Simultaneous inclusion of all relevant covariates	1.98	1.91	1.39	0.25

Numbers in parentheses indicate F-values for the covariates in question.

and no developmental trends could be detected. This was particularly true for comparisons among tasks differing with regard to content and structure, that is, for comparisons among laboratory-type and everyday memory tasks. Hence, these findings correspond well with those obtained in the old correlational studies summarized earlier and those reported by Stevenson et al. (1968). The pattern of results found for the two subsamples of elderly adults differed from that for the child sample in that remarkably higher intertask correlations were obtained, particularly when the younger subgroup was considered. Thus it appears that generally higher intraindividual consistencies with regard to performance in various memory tasks can be assumed for this age group. Unfortunately, the fact that we do not yet have any comparable information available concerning intraindividual consistencies in memory performance for subjects aged between 15 and 50 years, there is no possibility to infer life-long developmental trends from the data presented in this study.

When the more liberal criterion was used, the expected improvement, that is, substantially high percentages of subjects showing high intertask consistency, was not supported by the data. Although the absolute number of subjects classified as consistent may have been underestimated due to the fact that no attempt was made to take standard error of measurement into account, the results seem to replicate the findings obtained by intertask correlations. Again, no evidence for the existence of a unitary memory function could be found. It should be noted, however, that the laboratory-type memory tasks and everyday memory task used in this study differed with regard to several aspects. Theoretically, it should be possible to construct tasks representing different degrees of ecological validity that could be more similar concerning task structure and contents. Probably, the inclusion of such a set of tasks would lead to more positive results, that is, higher intertask consistency.

As a consequence, the last step of analysis focused on the explanation of age group differences, separately for each memory task. The findings are particularly interesting with regard to the child sample: Effects of age on the various memory performance measures could be remarkably reduced when covariates like memory capacity, strategy use, and metamemory were taken into account. The substantial effect of domain-specific knowledge on performance in the task assessing memory for prose underlines the theoretical and practical importance of preexisting knowledge structures. Probably, the major difference between laboratory type-tasks and memory problems occurring in everyday-life situations lies in the fact that domain-specific knowledge plays an important role in the latter but not in the former situation. As far as we can judge, it is quite unclear from the literature how domain-specific knowledge is activated in children and if it is used differently in different age groups. This seems to be an interesting question for future research.

Another implication of the present findings for future research in memory concerns the problem that all-too-few different memory tasks have been used in traditional experimental studies. This has been partly due to the fact that the logical analysis of the task structure and the processes involved in its solution has been the main reason for adopting memory tasks, and partly due to the belief that results obtained for one type of task should be also valid for other types of memory tasks. Obviously, the latter assumption is not true. As a consequence, future researchers in memory development are therefore encouraged to include different versions of similar memory tasks in their experimental design (e.g., laboratory-type tasks versus everyday memory tasks with a similar logical task structure) to better control for ecological validity of their findings.

REFERENCES

Anastasi, A. (1932). Further studies on the memory factors. *Archives of Psychology, 20,* No. 142.

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: a proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 2). New York: Academic Press.

Balinsky, B. (1941). An analysis of mental factors of various age groups from nine to sixty. *Genetic Psychology Monographs, 23,* 191–234.

Bolton, E. B. (1931). The relation of memory to intelligence. *Journal of Experimental Psychology, 14,* 37–67.

Brown, A. L. (1975). The development of memory: Knowing, knowing about knowing, and knowing how to know. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 10). New York: Academic Press.

Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, remembering, and understanding. In J. H. Flavell & E. Markman (Eds.), *Handbook of developmental psychology* (Vol. 3). New York: Wiley.

Burt, C. (1954). The differentiation of intellectual abilities. *British Journal of Educational Psychology, 24,* 76–90.

Campione, J. C., & Brown, A. L. (1977). Memory and metamemory development in educable retarded children. In R. V. Kail & J. W. Hagen (Eds.), *Perspectives on the development of memory and cognition*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Campione, J. C., & Brown, A. L. (1978). Toward a theory of intelligence: contributions from research with retarded children. *Intelligence, 2,* 279–304.

Campione, J. C., Brown, A. L., & Bryant, N. R. (1985). Individual differences in learning and memory. In R. J. Sternberg (Ed.), *Human abilities*. New York: Freeman.

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

Chase, W. G., Lyon, D. R., & Ericsson, K. A. (1981). Individual differences in memory span. In M. P. Friedman, J. P. Das, & N. O'Connor (Eds.), *Intelligence and learning*. New York: Plenum.

Cohen, R. L. (1982). Individual differences in short-term memory. In N. R. Ellis (Ed.), *International review of research in mental retardation* (Vol. 11). New York: Academic Press.

Cronbach, L. J. (1957). The two disciplines of scientific psychology. *American Psychologist, 12,* 671–684.

Dempster, F. N. (1981). Memory span: Sources of individual and developmental differences. *Psychological Bulletin, 89,* 63–100.

Ebbinghaus, H. (1885). *Über das Gedächtnis*. Leipzig: Dunker.

Estes, W. K. (1974). Learning theory and intelligence. *American Psychologist, 29,* 740–749.

Flavell, J. H. (1971). What is memory development the development of? *Human development, 14,* 225–286.

Flavell, J. H. (1981). Cognitive monitoring. In P. Dickson (Ed.), *Children's oral communication skills.* New York: Academic Press.

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: Erlbaum.

Friedman, H. (1974). Interrelation of two types of immediate memory in the aged. *Journal of Psychology, 87,* 177–181.

Gagné, R. M. (1967). *Learning and individual differences.* Columbia, OH: Charles E. Merrill.

Garrett, H. E. (1946). A developmental theory of intelligence. *American Psychologist, 1,* 372–378.

Hagen, J. W., Jongeward, R. H., & Kail, R. V. (1975). Cognitive perspectives on the development of memory. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 10). New York: Academic Press.

Humphreys, M. S., Lynch, M. J., Revelle, W., & Hall, J. W. (1983). Individual differences in short-term memory. In R. F. Dillon & R. R. Schmeck (Eds.), *Individual differences in cognition* (Vol. 1). New York: Academic Press.

Hunt, E., Frost, N., & Lunneborg, C. L. (1973). Individual differences in cognition: A new approach to intelligence. In G. Bower (Ed.), *Advances in learning and motivation* (Vol. 7). New York: Academic Press.

Hunt, E., & Lansman, M. (1975). Cognitive theory applied to individual differences. In K. W. Estes (Ed.), *Handbook of learning and cognitive processes* (Vol. 1). Hillsdale, NJ: Lawrence Erlbaum Associates.

Kail, R. V. (1979). Use of strategies and individual differences in children's memory. *Developmental Psychology, 15,* 251–255.

Katzenberger, L. (1964). *Dimensionen des Gedächtnisses.* Unveröffentlichte Dissertation, Universität Würzburg.

Kirby, J. R. (1980). Individual differences and cognitive processes: instructional application and methodological difficulties. In J. R. Kirby & J. B. Biggs (Eds.) *Cognition, development and instruction.* New York: Academic Press.

Kreutzer, M. A., Leonard, C., & Flavell, J. H. (1975). An interview study of children's knowledge about memory. *Monographs of the Society for Research in Child Development, 40,* Serial No. 159.

Lee, A. L. (1925). An experimental study of retention and its relation to intelligence. *Psychological Review Monographs, 34.*

McCall, R. (1977). Challenges to a science of developmental psychology. *Child Development, 48,* 333–344.

Meumann, E. (1907). *Vorlesungen zur Einführung in die experimentelle Pädagogik und ihre psychologischen Grundlagen.* Leipzig: Klinkhardt.

Meumann, E. (1918). *Ökonomie und Technik des Gedächtnisses* (Vol. 1). Leipzig: Klinkhardt.

Perlmutter, M., & Lange, G. (1978). A developmental analysis of recall-recognition distinctions. In P. A. Ornstein (Ed.), *Memory development in children.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Reinert, G. (1970). Comparative factor analytical studies of intelligence throughout the human lifespan. In L. R. Goulet & P. B. Baltes (Eds.), *Life-span developmental psychology: Research and theory.* New York: Academic Press.

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.

Stevenson, H. W., Hale, G. A., Klein, R. F., & Miller, L. K. (1968). Interrelations and correlates in children's learning and problem solving. *Monographs of the Society for Research in Child Development, 33.*