CHAPTER 17

Expert Knowledge, General Abilities, and Text Processing

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Introduction

Although it has been recognized for some time that memory performance is highly dependent on the developing knowledge base, systematic studies on the impact of task-relevant prior knowledge on memory behavior and performance have only been carried out in the last decade. The findings have been so striking that in recent descriptions of memory development knowledge base or domain-specific knowledge has been considered an extremely important source of memory development (e.g., Bjorklund, 1985, 1987; Chi & Ceci, 1987; Ornstein & Naus, 1985; Schneider & Pressley, 1989; Siegler, 1986).

In numerous studies, it has been shown that domain-specific knowledge influences how much as well as what children recall. Research has further indicated that age-related differences in measures of basic memory capacities and strategies may be due to changes in domain-specific knowledge. Mediation via strategies may actually be one of the most salient ways by which prior knowledge influences memory performance (cf. Ornstein & Naus, 1985; Siegler, 1986). As Pressley, Borkowski, and Schneider (1987) pointed out, there are at least three types of mechanisms through which domain-specific knowledge relates to strategy use: Knowledge can either facilitate the use of particular strategies, generalize strategy use to related domains, or even diminish the need for strategy activation.

With regard to the last mechanism, the assumption is that many instances of efficient learning occur without strategic assistance and that domain-specific knowledge can affect memory performance directly (cf. Chi, 1981). That is, in some instances, developmental increases in memory performance may be due primarily to development and application of the knowledge base rather than to development of strategic competence.

In this chapter, we only consider empirical evidence indicating direct effects of the knowledge base on memory performance. That is, we will not deal with the numerous studies on knowledge–strategies interactions that already have been covered in many thorough reviews (e.g., Bjorklund, 1987; Chi, 1985; Ornstein & Naus, 1985; Rabinowitz & Chi, 1987). Instead, the focus is on the

impact of domain-specific knowledge on text processing in highly articulated domains. The area of text processing was chosen because deliberate, conscious strategies may not play a major role in memorizing and comprehending text materials (cf. Pressley, Forrest-Pressley, & Elliott-Faust, 1988).

A second restriction is implied by our focus on results from the expert–novice paradigm. That knowledge can affect children's memory for texts has been confirmed already in studies of "inferential" memory conducted in the seventies by Paris (1975; Paris & Lindauer, 1977). The conclusion drawn from this work was that children can use their knowledge and go beyond the facts presented in a text in order to fill in the gaps in information to be remembered. It is important to note, however, that these studies dealt with the effects of *general* knowledge or *semantic* knowledge on text processing, whereas we attempt to provide an analysis of how *domain-specific* knowledge may influence text processing in the domain of interest.

The expert–novice paradigm represents what Voss, Fincher-Kiefer, Green, and Post (1986) labeled the "contrastive approach" to knowledge: the question is how a specific or basic characteristic of individuals (e.g., some type of knowledge assessment) is related to performance on some other task termed the comparison task (in our case: text processing). Thus far, studies using the expert–novice paradigm have yielded impressive evidence for the important role of domain-specific knowledge in memory performance. Perhaps the most robust finding in the literature on knowledge effects is that experts in an area learn more when studying new information in their domain of expertise than do novices in that domain (cf. Voss et al., 1986, Körkel, 1987 for reviews).

Analyzing the literature on the role of expert knowledge in learning from text, we focus on three different questions that have been rarely addressed in studies using the expert-novice paradigm:

1. Are there developmental or age-related differences between expert and novice knowledge representation?
2. How should we conceptualize the relationship between domain-specific knowledge and (general) metacognitive knowledge? Is it solely the richness of domain-specific knowledge that distinguishes expert from novice performance, or do individual differences in procedural and declarative metacognitive knowledge contribute as well to performance differences?
3. How do individual differences in general cognitive abilities relate to the acquisition and use of domain-specific knowledge? More specifically, can domain-specific expertise compensate for low overall aptitude on certain domain-related cognitive processing tasks?

In our view, the first question addresses a problem specific to the contrastive method. Given the fact that one objective in using the contrastive method is to view expert and novice performance on the comparative tasks as a cross-sectional approach to the study of knowledge acquisition, the analysis of developmental differences of expert and novice performance in a specific domain may prove more informative than the usual comparison of adult experts and novices.

This is particularly true when the goal is to develop ideas about how a novice in a domain may eventually become an expert.

Regarding the second question, most studies assessing the impact of expert knowledge on text processing have neglected possible influences of metacognitive knowledge. Researchers investigating the development of various aspects of text processing in random samples have repeatedly emphasized the relevance of metacognitive factors for efficient text recall and comprehension (cf. Forrest-Pressley & Waller, 1984; Garner, 1987). What we need to explore in more detail is whether a particularly rich knowledge base can compensate for low metacognitive knowledge, regardless of age.

There are differences in opinion concerning the role of general cognitive abilities in acquiring and using expert knowledge. On the one hand, it seems intuitively plausible that high-aptitude individuals should be able to acquire expertise in a given domain much faster than low-aptitude persons. Further, they should be more likely to apply their expert knowledge in tasks involving the acquisition of new information in the designated domain. On the other hand, given the striking effect of rich domain-specific knowledge on cognitive performances, one could also claim that domain-specific expertise may compensate for low overall aptitude on certain domain-related cognitive processing tasks. The remainder of this chapter will provide pertinent empirical evidence to clarify these points.

Expert Knowledge and Text Processing

Evidence From Adult Samples

Jim Voss and his colleagues (Chiesi, Spilich, & Voss, 1979; Spilich, Vesonder, Chiesi, & Voss, 1979; Voss, Vesonder, & Spilich, 1980) employed knowledge of a particular subject matter domain, baseball, as the basic characteristic, with the processing of text serving as the comparative task. Spilich et al. (1979), for example, first assessed subjects' domain-specific knowledge of the terminology, rules and strategies of the game of baseball. Next, a passage dealing with a baseball game was presented. The passage also contained neutral material (presumed to be equally familiar to high- and low-knowledge individuals) unrelated to the topic of baseball. As expected, the baseball experts recalled not only more information, but also more important information than baseball novices. The baseball novices recalled as much unimportant information as important information, recalling more actions irrelevant to the progress of the game.

Voss et al. (1980) further showed that recall of baseball experts was superior to that of baseball novices, even when the passages were self-generated, that is, when each person generated a passage and subsequently recalled it. Interestingly, an interaction effect of passage contents and knowledge was demonstrated. Baseball experts showed better recall than baseball novices when recalling passages generated by baseball experts. On the other hand, there was

little difference in performance between knowledge groups when subjects recalled passages generated by baseball novices. Based on this finding, Voss et al. (1980) concluded that knowledge is related to text recall when stimulus materials are sufficiently sensitive to provide for detection of knowledge differences. The interaction effect revealed in their recall data seems to further indicate that knowledge differences in recall are by no means a necessary outcome when a domain-related text is being processed. Nevertheless, the findings reported by Voss and his colleagues demonstrate that the knowledge base influences how much and what subjects recall. In particular, the qualitative differences in memory errors of experts and novices (entailing substitution of details in the case of experts, and rule violations in the case of novices) indicate that existing knowledge provides a powerful framework for organizing new information and serves as a base against which to check the plausibility of recalled sequences (cf. Siegler, 1986).

Developmental Studies

As mentioned above, only a few studies have been conducted on child experts' performances with respect to text recall and comprehension tasks. Some of these studies were not truly developmental in nature because they were based on a single age group. For instance, Pearson, Hansen, and Gordon (1979) used second graders who could be categorized as snake experts or novices. The children were given a short text about snakes. Subsequent questions dealt with information explicitly presented in text, as well as facts that were only implied in text but could be inferred based on prior knowledge. As expected, the experts outperformed the novices. The relatively greater superiority of experts on text-implicit questions was assumed to be due to the operation of a snake-content schema possessed by the experts but not by the novices. The study thus shows that the strong effects of domain-specific knowledge on text processing repeatedly found for adults can be generalized to samples of young children.

In comparison, developmental studies using child experts and novices have two additional advantages. First, they allow for an estimate of how greatly domain-specific knowledge can influence children's memory performance. This was impressively demonstrated, for example, by Chi (1978) who recruited experienced and unexperienced chess players and assigned them the task of recalling various chess positions. The most interesting aspect of this research was that subjects' knowledge correlated negatively with age: Children (average age = 10 years) were the experts and adults were the novices. Although the children performed worse on traditional memory-span tests than the adults, they reproduced the chess configurations more accurately than the adults. The study provided evidence supporting the idea that domain-specific knowledge enables a child expert to perform much like an adult expert and better than an adult novice, thus showing a reversal of usual developmental trends.

A second advantage of developmental studies using the expert–novice paradigm is that differences between expert and novice knowledge representations

can be compared for different age groups. Assuming that developmental differences in cognitive performance may be accounted for, at least in part, by differences in domain-specific knowledge, the issue of how expertise may change with age seems particularly important.

Stimulated by Chi's (1978) findings, our research group conducted two developmental studies dealing with the impact of soccer expertise on recall and comprehension of a story dealing with a soccer game. A total of 576 third, fifth, and seventh graders participated in the first, large-scale study (see Knopf, Körkel, Schneider, & Weinert, 1988; Schneider, Körkel, & Weinert, 1989; Weinert, Knopf, Körkel, Schneider, Vogel & Wetzel, 1984, and Weinert, Schneider, & Knopf, 1988, for a more detailed description of the study). The main reason for choosing soccer as a topic was its great popularity in West Germany. Hence, it is easy to find soccer experts even among young children. Approximately half of the subjects across all age groups were classified as soccer experts and half as novices, according to their performance on a questionnaire tapping knowledge about soccer rules and important soccer events. All subjects were also presented with a narrative test dealing with a soccer game. Although the text was generally easy to understand even for novices, some important information was occasionally omitted and had to be inferred by the reader. Moreover, several contradictions were built into the text that could only be detected by careful reading. While prior knowledge about soccer was important for drawing correct inferences, it was not always necessary for detecting the contradictions in the text. A comprehensive questionnaire was used to assess memory for text details, ability to draw inferences, and the ability to detect contradictions in the text.

A total of 185 third, fifth, and seventh graders participated in the second study (Körkel, 1987). The same questionnaire assessing knowledge about soccer and the same story about a soccer game were used. However, Körkel's study differed from the first study with respect to the outcome measures used. Children were instructed to recall the story as accurately and comprehensively as possible. The recall protocols were analyzed according to a procedure developed by Mandler and Johnson (1977), that is, in terms of "semantic" or idea units. Additional memory measures included a cloze test and a recognition test. In the cloze test, all subjects were presented with a written version of the story that included 20 blanks, to be filled in as accurately as possible. About half of the sentences in the recognition test were "old," that is, original sentences, whereas the other half consisted of distractor items very similar to sentences originally presented in the story.

The analysis of recall and comprehension measures yielded similar patterns of results for both studies. There were significant main effects for grade and expertise on all three outcome measures assessed in the first study (cf. Weinert et al., 1984, 1988). In general, older children outperformed younger subjects, and experts were significantly better than novices at each age level. No significant interactions were found between age and expertise.

The analysis of Körkel's (1987) free-recall data yielded significant main ef-

fects of grade and expertise: While seventh graders recalled more text units than both third and fifth graders, experts outperformed novices at each grade level. As depicted in Table 17.1, the findings do confirm Chi's results in that a reversal of developmental trends was demonstrated. Third-grade experts recalled significantly more text units than both fifth-grade and seventh-grade novices. Similarly, fifth-grade experts outperformed seventh-grade novices. Thus, this study again demonstrated how greatly domain-specific knowledge can influence memory performance.

The findings for the stimulated recall (cloze tests) were different in that no effect for grade level was found. Significant effects were again found for expertise, regardless of grade level, although they were less pronounced than for the free-recall measure. Interestingly, no significant effects whatsoever were found for the recognition test.

As a whole, these findings suggest that there is an interaction between knowledge level and form of test: The easier the memory task, the more soccer novices benefit from memory prompts. This conclusion was also supported by a further analysis of Körkel's (1987) recall data. In addition to the story also used in the Weinert et al. (1984) study, Körkel included an easier text version that did not require children to infer information from text. The recall data for the two story versions are contrasted in Figure 17.1. Figure 17.1 illustrates an interaction between knowledge level and task difficulty: Whereas soccer experts' recall was not affected by text difficulty, soccer novices performed significantly better when presented with the easier text version.

How did expertise change over time? Results from both studies indicated that older experts generally knew more than younger experts. However, there was no indication that knowledge representation is qualitatively different in older experts regardless whether Mandler and Johnson's (1977) protocol analysis or Brown and Smiley's (1977) importance rating procedure was used (cf. Körkel, 1987). In general, younger as well as older soccer experts tended to recall the important text units and to ignore information less central to a proper understanding of the text.

This finding does not necessarily generalize to other domains. Means and Voss (1985) conducted a developmental study of expert and novice knowledge structures by using the domain of "Star Wars." Expert and knowledge groups were delineated within each of six grade levels: 2, 3, 5, 7, 9, and college. A

TABLE 17.1. Mean percentage of idea units recalled as a function of grade and expertise.

Grade	Soccer experts	Soccer novices
3	54	32
5	52	33
7	61	42

Data from Körkel, 1987.

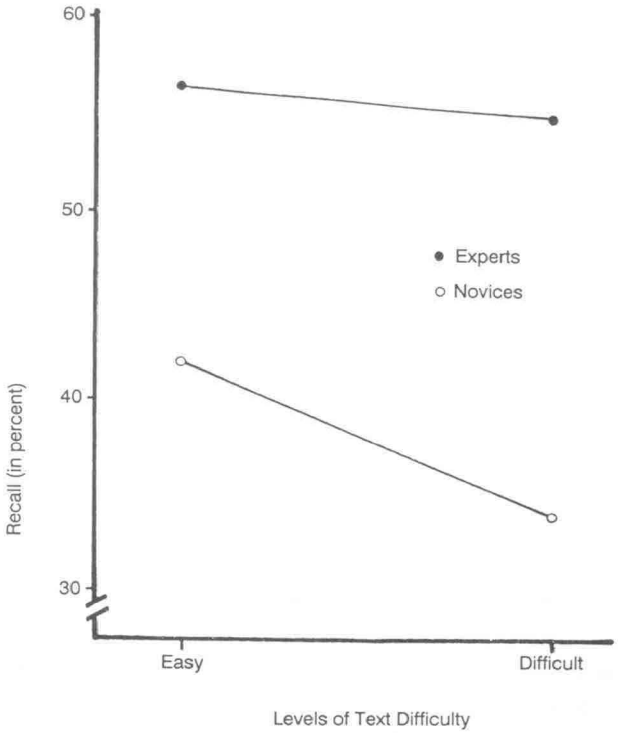

FIGURE 17.1. Mean text recall (percentage correct), as a function of expertise and story version (data from Körkel, 1987).

hierarchical structure of "Star Wars" containing high-level goals, subgoals, and basic actions was constructed. Similar to the findings by Körkel (1987) and Weinert et al. (1984), all analyses yielded significant effects for knowledge and age and only one significant interaction. Older experts were shown to be *quantitatively superior* to younger experts. In addition, Means and Voss (1985) found *qualitative differences* in the "Star War" representations of younger and older experts. While the older experts seemed to interpret "Star Wars" in relation to an "international conflict" schema involving interrelated political–moral–military components, the younger experts tended to interpret "Star Wars" in reference to a military-oriented "good-guy–bad guy" schema. This finding indicates that individual differences in world knowledge can be an additional component of age-related performance differences. According to Means and Voss, the qualitative differences of the "Star Wars" representation for the experts of different ages may be attributed to differential prior schematic knowledge: The older experts have a more developed schema involving the complexities of international conflict, whereas the younger experts have a military-oriented "good guy–bad guy" schema. Altogether, the results presented in this section indicate that—at least for some domains—knowledge components outside the specific domain in question must be taken into account

in order to determine what makes a younger expert an older expert. They also indicate, however, that our findings concerning soccer expertise may not necessarily generalize to other domains.

Relations Between Domain-Specific Knowledge and Metacognitive Knowledge

Conceptually linking different types of knowledge is not an easy task. In the case of domain-specific knowledge and metacognitive knowledge, formal similarities in conceptualization are immediately apparent. Domain-specific knowledge can take two forms, declarative and procedural. Declarative knowledge is factual in nature: For example, the questions concerning soccer rules and events provided in our soccer knowledge test refer to declarative knowledge. Procedural knowledge, on the other hand, is knowledge about how to do things. Declarative knowledge can be distinguished from procedural knowledge by the way it is represented. According to many developmentalists (e.g., Bjorklund, 1987; Chi, 1987; Chi & Ceci, 1987; Rabinowitz & Chi, 1987) declarative knowledge can be represented in terms of network models of semantic memory. They assume that every item or concept in semantic memory is represented by nodes which are connected to each other by means of links. The degree of complexity of the semantic network should correspond to the elaborateness and organization of a child's declarative knowledge. In defining procedural domain-specific knowledge, Chi (1987) is strongly oriented to computer models. Accordingly, procedural knowledge can be represented as a set of production rules. While it is not our intention to review this conception in detail, an example may clarify this point: Knowing how to play soccer would be considered procedural domain-specific knowledge, whereas knowing about the rules or facts related to soccer would be considered declarative domain-specific knowledge.

With respect to metacognitive knowledge, a similar distinction between declarative and procedural components can be made. Among others, Brown, Bransford, Ferrara, and Campione (1983) have noted that children possess two basic types of knowledge about memory. One type is declarative, factual knowledge about the importance of person variables, tasks, and strategies for memory performance. Another is metacognitive knowledge which subsumes more implicit procedural knowledge about how to regulate and monitor memory. For example, explicit knowledge about strategies suited to learn and remember text materials would be considered declarative metacognitive knowledge, whereas feeling-of-knowing statements concerning the reconstruction of text details would be considered procedural metacognitive knowledge.

A final similarity concerns the fact that declarative and procedural components are conceived of as rather independent in both conceptions of domain-specific and metacognitive knowledge (cf. Brown et al., 1983; Siegler, 1986; Voss et al. 1986). Empirical findings seem to support this view. With regard to

our two soccer studies, the active soccer players in the samples did not outperform inactive soccer experts on the soccer knowledge test (see Voss et al., 1986 for a similar account on football players). As to metacognitive knowledge, Schneider,Körkel, and Weinert (1987) found no empirical relationship between declarative and procedural knowledge variables.

In our view, this evidence makes it difficult to conceptualize procedural and declarative components of both domain-specific knowledge and metacognitive knowledge within a unitary theoretical framework. Apparently, information can be processed through different channels, and the issue of conceptually combining semantic networks and production systems still has to be solved.

While our two studies on soccer expertise were not designed to clarify these conceptual problems, they were suited to explore the issue of how (1) declarative metacognitive knowledge contributes to soccer experts' memory performance and (2) how expert knowledge may influence procedural metacognitive knowledge.

Interactions Between Declarative Metacognitive Knowledge and Expert Knowledge in Text Recall

In both studies on soccer expertise, we presented subjects with a comprehensive questionnaire that tapped metacognitive knowledge about various aspects of text recall (see Körkel, 1987; Schneider et al., 1989, for a more detailed description). As the questionnaire assessed *general*, domain-nonspecific metacognitive knowledge we did *not* expect our experts and novices to differ on this measure. If, on the other hand, individual differences in metacognitive knowledge are indeed important for recall of the soccer story, within-group comparisons should bring this to bear. Accordingly, we assumed that in both the soccer-related expert and novice groups, subjects with high metacognitive knowledge would outperform those with low metacognitive knowledge.

As can be seen from Figure 17.2, the results clearly confirmed our prediction. In both the expert and novice groups, subjects with high metacognitive knowledge recalled significantly more text units than their counterparts with low metacognitive knowledge. This finding demonstrates that the combination of rich domain-specific knowledge and metacognitive knowledge leads to optimal performance.

Relations Between Domain-Specific Knowledge and Procedural Metacognitive Knowledge

Our expectations concerning the relationship between domain-specific knowledge and procedural metacognitive knowledge differed from those developed for the interaction between domain-specific knowledge and declarative metacognitive knowledge. Typically, procedural metacognitive knowledge is closely linked to the designated domain. For example, predicting the number of items one will remember may be dependent on both familiarity with the item as

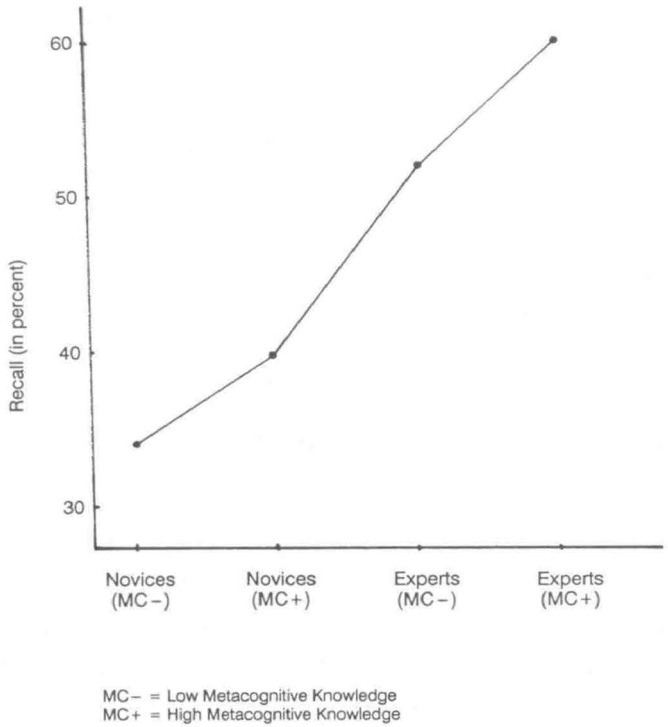

FIGURE 17.2. Mean text recall (percentage correct), as a function of expertise and metacognitive knowledge (data from Körkel, 1987).

well as the ability to monitor ongoing cognitive processes. Consequently, our assumption was that soccer experts should outperform soccer novices on tasks involving procedural metacognitive knowledge.

Chi (1978) has already provided empirical support for this hypothesis. In her study, young chess experts predicted their performance on chess-related memory tasks more accurately than adult chess novices. Not only did we adopt the performance prediction paradigm, but we also included a "feeling-of-knowing" task. In the performance prediction task, subjects were asked to predict how many sentences of the soccer story they would be able to remember correctly. After responding to each item of the cloze test, subjects were required to give a "feeling-of-knowing" judgment. That is, children had to indicate how certain they were that they had filled in the blanks correctly. Results were straightforward, with soccer experts outperforming soccer novices on both tasks, regardless of age. These differences in performance were quite impressive: On the "feeling-of-knowing" task, for example, the soccer experts correctly answered about 85% of the items, as compared to 65% correct answers for the novices. Somewhat surprisingly, no significant age differences were found in each group.

Altogether, the results indicate that expert knowledge has a strong impact on the quality of procedural metacognitive knowledge. Obviously, this finding is not restricted to text processing: Sort–recall experiments conducted by Hasselhorn (1986; Weinert & Hasselhorn, 1986) revealed that high performance on a sort–recall task was determined by both metacognitive knowledge and the knowledge base. In our view, the most interesting aspect of the findings in soccer expertise studies is that metacognitive knowledge does have some effect on cognitive performance even when domain-specific knowledge is very rich.

General Abilities and Domain-Specific Knowledge

During the early phases of research on expert–novice differences, it was not yet known whether domain-independent skills (e.g., general reasoning abilities) or domain-specific knowledge was more important in distinguishing expert and novice performance (cf. Gagné, 1985). Meanwhile, numerous research examples have demonstrated the relatively greater impact of experts' domain-specific knowledge on various task outcomes (cf. Ericsson & Crutcher, 1989; Gagné, 1985). Given the striking effects of experts' domain-specific knowledge on cognitive performance, a related question of interest is whether it is possible for domain-specific expertise to even compensate for low general cognitive abilities.

According to more recent conceptualizations of intelligence, high-aptitude individuals possess factual knowledge in many domains, whereas low-aptitude individuals lack experience in all but a few domains (cf. Garcia, 1981; Siegler & Richards, 1982; Sternberg & Wagner, 1985). As psychometric intelligence tests usually sample knowledge from a wide variety of domains, the finding that low-ability individuals (as classified according to these tests) normally process information less effectively and efficiently than high-ability subjects may be due to the fact that their information-processing ability is assessed in domains with which they are not particularly familiar. Hence, tests assessing psychometric intelligence or general cognitive abilities may underestimate low-ability individuals' comprehension, memorization, or decision-making skills in the few domains with which they are highly familiar. If this assumption is correct, individual differences in global reasoning abilities should not prove important when the task involves acquisition and processing of new information within a domain that is highly familiar to all subjects.

This issue has been addressed in two secondary analyses based on the two studies on soccer expertise (cf. Schneider, Körkel, & Weinert, 1989; Schneider & Körkel, in press). As several indicators of intellectual ability (i.e., psychometric intelligence tests) were available in both studies, the samples of soccer experts and novices could be divided into subgroups of high- and low-aptitude children. Thus, four groups resulted at each grade level: High- and low ability soccer experts, and high- and low ability soccer novices.

All recall and comprehension measures included in the two original studies

were used again in the reanalysis of the cross-sectional data (Schneider et al., 1989). These data were analyzed in several ANOVAs, using grade, expertise, and general abilities as independent factors. Most strikingly, neither a single effect was found for general ability, nor were there any significant interactions. High- and low-aptitude soccer experts performed equally well on all measures of text recall and comprehension. Apparently, domain-specific knowledge can sometimes compensate for overall lack of general cognitive abilities.

In one study conducted (Weinert at al., 1984), longitudinal data were also available. Here, knowledge about soccer as well as text recall and comprehension were reassessed 1 year later when the children were in grades four, six, and eight. The major purpose of the secondary analysis of these data (Schneider & Körkel, in press) was primarily designed to validate the findings reported for the cross-sectional data.

A first important finding was that the expert–novice classification proved to be stable over time. About 78% of the fourth graders, 83% of the sixth graders, and 92% of the eighth graders were consistently classified as soccer experts or novices for both occasions. Significant increases in soccer knowledge over time were obtained only for the youngest age group. Additional analyses revealed

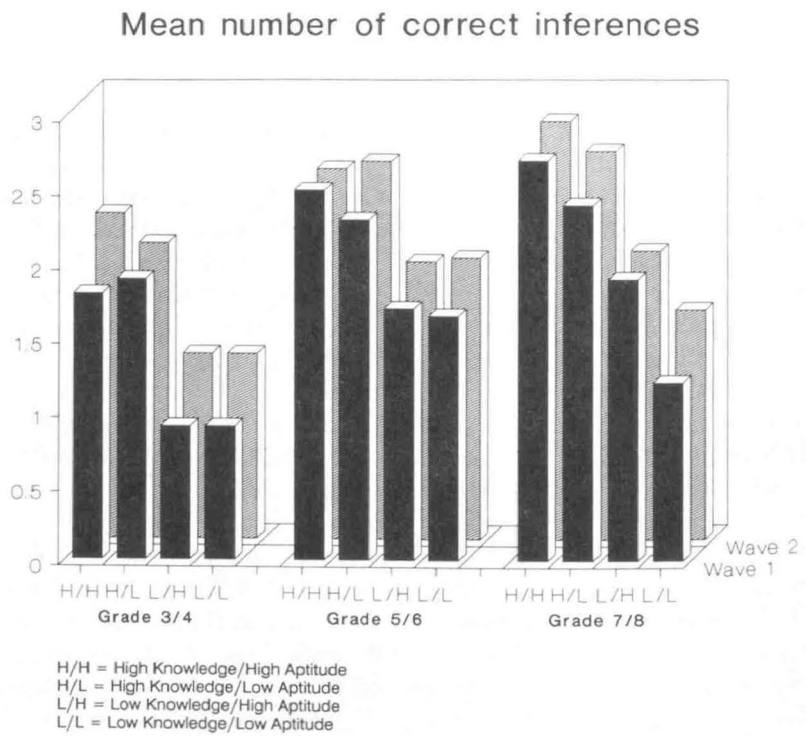

FIGURE 17.3. Mean number of correct inferences, as a function of grade, expertise, and general ability.

that while experts' soccer knowledge tended to improve over time, this was not true for soccer novices.

Factorial analyses of variance including grade, expertise, and general aptitude as independent factors were conducted on posttest memory for text details, correct inferences, and detection of contraditions. Replication was possible for the findings reported during the first wave. Grade and expertise revealed effects on all three dependent variables, but neither effects for general ability nor any significant interactions were found.

The most impressive findings stem from the two text comprehension measures (i.e., correct inferences and detection of contradictions). Figures 17.3 and 17.4 contain the means for these variables obtained for both occasions as a function of grade, expertise, and general ability. Longitudinal analysis of these data revealed effects only for grade level. Overall performance increases were obtained over time for all dependent variables. Additional analyses revealed that fourth graders gained significantly more under all conditions than the two other age groups, which did not differ from each other. Somewhat surprisingly, performance gains were neither affected by soccer expertise nor by general abilities. However, the findings reported in the earlier investigation were val-

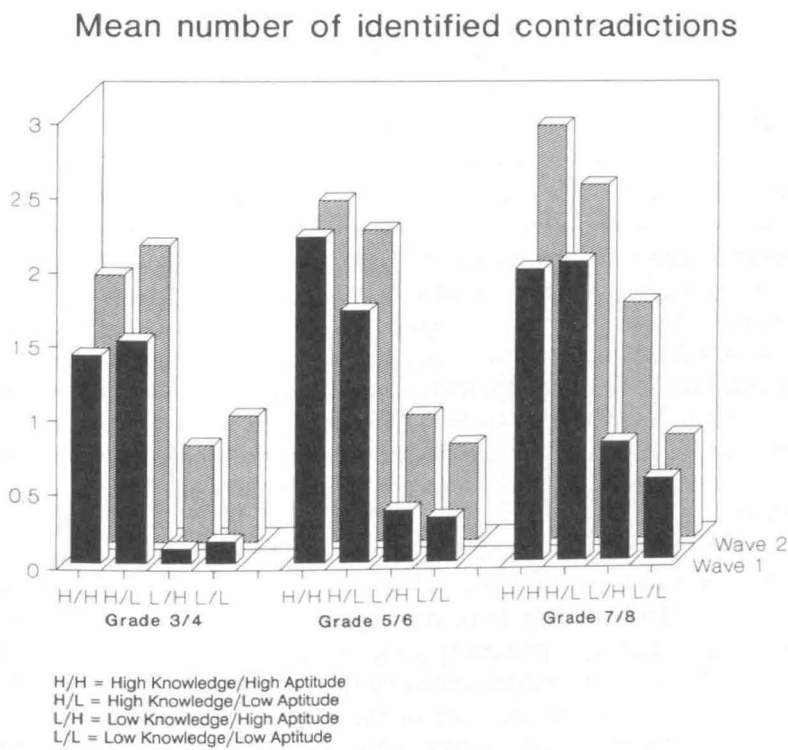

FIGURE 17.4. Mean number of contradictions identified in the text, as a function of grade, expertise, and general ability.

idated by the results of the replication study, thus suggesting that domain-specific expertise can compensate for low overall ability on domain-related cognitive processing tasks.

There is also evidence that these findings can be generalized to adult populations and other domains. Walker (1987) compared high- and low-aptitude adults who were either baseball experts or novices. When presented with a baseball text passage, low-aptitude/high-knowledge subjects recalled more information than high-aptitude/low-knowledge subjects. In addition, the performance of the two baseball expert groups was comparable with regard to the importance of information recalled and the number of goal relevant inferences. Ceci and Liker (1986) demonstrated that adults who appeared to be operating at low levels of intellectual functioning (e.g., IQs in the 80s) were capable of complex classification and reasoning processes when the stimuli were highly familiar. According to Ceci and Liker, low-IQ subjects were able to engage in a form of multiple-regression-thinking, when they attempted to select racetrack winners. Both studies demonstrate that (1) tests of general mental ability underestimate comprehension and strategic thinking skills of individuals who lack exposure to all but a few domains and (2) that domain-specific expertise can indeed compensate for overall lack of aptitude.

Concluding Remarks

Taken together, the research reviewed in this chapter provides support for the assumption that domain-specific knowledge considerably influences children's memory performance. The findings illustrate that results obtained for adult samples can be generalized to school children. As we were unable to detect developmental differences between expert and novice knowledge representation in our soccer story paradigm, our results suggest that performance differences between older and younger soccer experts are due solely to *quantitative* differences in domain-specific knowledge. However, the findings presented by Means and Voss (1985) indicate that *qualitative* differences in domain-specific knowledge may be influential as well. More research is needed to elaborate on possible age-dependent differences in the structure of domain-specific knowledge, and how these differences may contribute to text processing in children and adults.

Our exploratory analyses regarding the interrelationship between metacognitive knowledge and domain-specific knowledge demonstrated that soccer experts' text recall can benefit from rich declarative metacognitive knowledge. Moreover, the amount of domain-specific knowledge available strongly influences the quality of procedural metacognitive knowledge, regardless of age. Thus, the findings not only demonstrate the striking effects of domain-specific knowledge on text recall and comprehension, but also show that different types of (metacognitive) knowledge may be influential as well. Yet, we still do not know very much about possible theoretical links between different knowledge

types. Representational systems that take the form of semantic network models definitively serve as a useful starting point, but may prove insufficient. As we are dealing with constructive memory, individual differences in schematic representation or script representation need to be considered separately. Further, the problem of how metacognitive knowledge relates functionally to both domain-specific knowledge and world knowledge needs to be addressed in order to arrive at a comprehensive theoretical model suitable to represent interactional structures among different types of knowledge in cognitive performance.

While it seems that much work is still needed to clarify this complicated issue, our findings concerning interrelationships between general abilities and domain-specific knowledge appear to be clear-cut. Our developmental studies clearly support the findings reported for adult samples. That is, individual differences in general ability do not seem to make a difference when the task is to process new information in a highly articulated domain. The fact that domain-specific expertise can compensate for low overall ability on domain-related cognitive processing tasks probably has important educational implications: Given this evidence, it seems reasonable and promising to try to teach low-ability learners to exploit their capabilities in other domains and other task situations.

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