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When can a lack of structure facilitate strategic processing of information?

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Background. Researchers examining the effectiveness of an elaboration strategy (answering 'why') for learning new information have been concerned with the familiarity of the materials and how that affects learning. It may be, however, that both how information is organised and familiarity impact on the potency of the strategy.

Aims. We examined the influence of presentation structures (i.e., organisation of information) on the effectiveness of an elaboration strategy.

Samples. All participants were undergraduates (78 females, 67 males) enrolled in a first-year psychology course. Fifteen students participated in Experiment One, 42 students in Experiment Two, and 88 students in Experiment Three.

Methods. In Experiment One, preference for conceptual organisation was assessed. In Experiments Two and Three, students answered 'why' questions when different presentation structures were used.

Results. Students' preferred method of organisation did not match the imposed structure found in past research, suggesting that students may have been restricted in their ability to process the information distinctively. Students who were presented with the information in a random order achieved the largest memory scores.

Conclusions. When students have to reconstruct as well as encode the information, these added task demands provide an added benefit for learning.

Elaboration strategies can be used to facilitate the efficiency and effectiveness of learning for individuals of all ages (e.g., Pressley *et al*., 1992). In fact, the use of elaboration strategies such as imagery and questioning is often a discernible feature between successful and unsuccessful learners (e.g., Wood, Willoughby, Reilley, Elliott, & DuCharme, 1995; Wood & Hewitt, 1993). Educators are becoming aware of the need

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to provide students with explicit knowledge about elaboration strategies in order to foster all students' ability to monitor their learning and hence, become more self-regulated. Given the potency of elaboration strategies, it is important to go beyond simply demonstrating that these strategies work to understanding the mechanisms that explain the elaborative process. Elaborations may be effective because they encourage active attention to the material (e.g., Wittrock, 1990) and the building of connections and associations to existing knowledge (e.g., Martin & Pressley, 1991; Willoughby, Wood, & Khan, 1994). Although the research is clear that elaboration strategies facilitate learning, when we directly ask students which strategies they typically use very few report using sophisticated strategies (Garner, 1990; Wood, Motz, & Willoughby, 1998) even though across development there is an increase in spontaneous strategy use (Pressley & Levin, 1977; Rohwer, 1973; Schneider & Pressley, 1997). It is important, therefore, to take a closer look at when, how, and why students employ elaboration strategies. The three experiments reported here investigate the interaction between structural demands (i.e., organisation of materials) and elaboration strategy use in order to understand why and how structural demands impact on learning. Specifically, the experiments investigate the role of structure with an elaboration strategy that has consistently facilitated students' learning, elaborative interrogation.

Elaborative interrogation is a verbal questioning strategy that promotes the generation of meaningful elaborations by requiring learners to answer 'why' questions, such as 'why would that fact be true?' The specific 'why' questions prompt learners to connect new information with existing knowledge. While answering the 'why' questions, learners activate and search their own wide body of knowledge that might otherwise not be activated (Sadoski, Paivio, & Goetz, 1991).

In fact, prior knowledge is thought to be a critical aspect of the successful use of elaborative interrogation as a study strategy (Kuhara-Kojima & Hatano, 1991; Martin & Pressley, 1991; Willoughby, Waller, Wood, & MacKinnon, 1993; Woloshyn, Pressley, & Schneider, 1992; Wood *et al.*, 1999). For example, when students are presented with novel facts about animals, using the elaborative interrogation strategy facilitates learning only when the animals are familiar. In contrast, there is no advantage for elaborative interrogation over repetition when unfamiliar animals are studied (Willoughby *et al.*, 1993).

Information from an unfamiliar domain may be more difficult because there are fewer links that can be made to the existing knowledge base (Willoughby *et al.*, 1994). For example, if presented with novel information about the Collared Peccary, an unfamiliar animal, students may be forced to link the novel information to very general categories such as 'animals'. In contrast, with familiar animals like the Western Spotted Skunk, very specific and distinctive links can be created between the novel information and existing knowledge (i.e., a more specific category such as 'skunk' is available in existing knowledge). The finer the discriminations constructed, the more distinctive the students make the material and subsequently, the more likely they will be able to remember it later (Einstein & Hunt, 1980; Marshark, Richman, Yuille, & Hunt, 1987; McDaniel & Einstein, 1986).

Given this interpretation, the conclusion could be made that elaborative interrogation is not the strategy of choice when learners have limited background knowledge. However, we suggest that this conclusion may be premature. At present, previous studies examining elaborative interrogation consistently have presented materials in a set order (e.g., Willoughby *et al.*, 1993, 1994). For example, an animal name first is identified followed by an ordered sequence of facts about that animal (e.g., habitat, diet, source of predation, living environment, social relationships, and unique characteristics – see Appendix A for an example). This structure is followed for each subsequent animal (i.e., always identify the animal label first followed with the ordered sequence of facts about that animal). It is possible that this imposed structure on the presentation of the material may impact on the effectiveness of elaborative interrogation and this impact may also affect learning about unfamiliar animals. For example, by restricting the organisation of the study material to animal type, students are forced to create links to very general categories in their knowledge base when presented with information about unfamiliar animals. If students are able to create their own organisation for the study material, they may be able to extrapolate other more familiar, specific categories and, therefore, be able to process the information more distinctively.

EXPERIMENT 1

Experiment 1 assessed students' preferred means of organising the animal facts conceptually, that is, students were asked to arrange the animal facts into different groups using any criteria they wished. In this way, we could assess whether students prefer to organise the facts according to animal type (e.g., fox, skunk, peccary, etc.) or whether they select a different form of categorisation, such as animal behaviours (i.e., preferred living environment, diet, source of predation, etc.). If students are at a disadvantage because of imposed structure (i.e., previous research always presented students with the study material organised in a set structure - by animal type), it is of interest to examine what criteria students would naturally use if presented totally unorganised information. Students in Experiment 1 were not required to learn the facts and had no exposure to the elaborative interrogation procedure.

Method

Participants and design

Fifteen students (6 men and 9 women) enrolled in a first-year psychology course participated in this experiment. Students were drawn from one university in a mid-sized Canadian city.

Materials

All students were exposed to the same 60 animal facts. Six statements described the type and special attributes of one of 10 animals (5 familiar and 5 unfamiliar animals). Each of the six statements described one characteristic of an animal (e.g., physical living environment, diet, source of predation). Five of the animals were judged to be familiar to students (i.e., Swift Fox, House Mouse, Little Brown Bat, Townsend Mole, and Western Spotted Skunk) and five were judged to be unfamiliar (i.e., pronghorn, coati, chickaree, American Pika, Collared Peccary). To ensure that the familiar and unfamiliar animals selected for this study would indeed correspond to undergraduate students' knowledge, Willoughby *et al*. (1993) pretested a comparable student population for familiarity with the animals and facts (see Appendix B for an example of a familiar and unfamiliar animal set). The 10 animals were chosen because the students indicated unanimously that they were either familiar with the animals (selected for the familiar animals) or unfamiliar with the animals (selected for unfamiliar animals). Each statement was typed on one white 12 cm × 19 cm card.

Procedure

Students were given the 60 randomly arranged cards containing the animal facts and instructed to sort the facts into groups using any criteria they wished. These students had no prior exposure to the animal facts before sorting the facts.

Results and discussion

Students used two predominant categories to organise the material. Sixty-seven percent of the students organised the information by behaviour. Six subcategories of the behaviour category were recognised. These subcategories included habitat, feeding behaviour, mating and reproductive behaviours, source of predation, biological and social characteristics, and communication behaviours. Thirty-three percent of the students organised the information by animal type. For example, all six facts for the American Pika were placed together.

Past studies exploring elaborative interrogation's effectiveness with animal facts have consistently organised the study facts according to animal type (Willoughby *et al.*, 1993, 1994). In contrast, our results suggest that students' preferred organisation would be to separate the facts according to behaviour. We could hypothesise, then, that organising the facts according to animal type may pose a disadvantage for students because this criterion is less preferred and hence may be less efficient for them. These concerns may be salient also when studying unfamiliar animal facts because students have the additional burden of having to categorise the information using categories for which they may have little or no existing prior knowledge. To find support for this hypothesis, we explicitly manipulated the presentation of materials in Experiments 2 and 3 to assess how the structural demands placed on students affect their learning.

EXPERIMENT 2

Experiment 2 compared the effectiveness of elaborative interrogation when different presentation structures were used. Specifically, the amount of structure in the study information was manipulated to represent increasing levels of structure: random, semi-structured, and structured. In this way, the impact of structure on learning could be directly assessed. First, students in one elaborative interrogation condition were presented with the study material in an identical format to past research. That is, presentation of the animal label was followed by facts about that animal, then the next animal and its corresponding facts, etc. (i.e., standard order – see Appendix B for order). All of the facts were organised to represent a static sequence of information (i.e., for each animal, the first statement was about their habitat, followed by diet, followed by source of predation, etc.). The second elaborative interrogation condition was a non-standard order that involved less structure than the standard condition. In this case, the order of animals remained constant with each animal presented in sequence, however, within each animal the facts were randomised so that no sequence was constant across animals (see Appendix B). Finally, in the third condition, all facts were presented in a random order. In this latter condition, it would be expected that students would generate and impose their own structure on the material. In this case, memory might be enhanced in comparison to the standard elaborative interrogation order of presentation because students must draw heavily from their existing knowledge to generate an appropriate category or impose a structure on the information.

Method

Participants and design

Forty-two students (19 men and 23 women) enrolled in a first-year psychology course participated in this experiment. Students were drawn from one university in a mid-sized Canadian city. Proportionally equal number of males and females were assigned to each condition. Students were randomly assigned to one of three study conditions (14 students in each condition): standard, non-standard, and random. All students were instructed to use the elaborative interrogation strategy but their study materials varied in presentation order.

Materials

All students in the study conditions were exposed to the same 60 animal facts from Experiment One (i.e., 6 facts about each of 5 familiar and 5 unfamiliar animals). In the standard condition, facts were presented in a static order consistent with previous research (Willoughby *et al*., 1993). For example, the first fact for all the animals always described where the animal lived. This information was always followed by what the animal liked to eat and so on. In the non-standard condition, animals were presented in the same constant order as for the standard order, but the order of facts within each animal was randomised. In the random condition, all of the facts were randomised. The identical random order was presented to all students in the random condition. Three cards served as examples that were used when instructions were provided to the students. The 60 remaining sentences were the study materials.

Procedure

All of the students were tested individually.Participants in the three study conditions were introduced to the task by being told that they would be shown individual sentences stating true facts about animals and that they would be asked to remember that information. Students were instructed to read each sentence and answer out loud the ‘why’ question written below each statement (i.e., why would that fact be true of that particular animal?). They were told that their answer should clearly state why the fact was true of the specific animal being discussed and not another similar animal.

Three example sentences were used to ensure that students could effectively execute the strategy. Feedback was provided about their performance. For example, students were prompted to elaborate their answer further or generate another elaboration if their answer did not explain the relation between the animal and its behaviour.

After practice, students were reminded of the instructions and the 60 facts were presented with no feedback provided. Each sentence was presented for 15 seconds. A paced presentation was used to ensure that all students had access to the material for the same amount of time across all study conditions. The study sessions were audiotaped in order to be able to check that students complied with the strategy instructions.

After presentation of the study material, all students were asked to complete a memory test. The experimenter presented each fact to the student in the form of a question (e.g., Which animal has a rapid rate of reproduction?). Students were required to select the appropriate animal name from a prepared list. Questions were presented in a random order with the stipulation that no more than two questions from one story could be presented contiguously.

Results and discussion

Consistent with previous research examining students' use of the elaborative interrogation strategy (see Willoughby *et al.*, 1994), the transcription of the study session audiotapes confirmed that all students complied with instructions and used their assigned strategy (i.e., they answered why each fact was true). The memory performance data for the three study conditions were analysed according to the total number of correct responses in the memory test.

A 2×3 repeated measures ANOVA was conducted on the memory test scores with familiarity of the material as the within-subjects variable and study condition as the between-subjects variable. There was a significant main effect for both study condition, $F(2,39) = 4.04$, $p < .05$ and familiarity, $F(1,39) = 159.42$, $p < .05$, $M = 20.05$ and 12.02 for familiar and unfamiliar animals, respectively. The interaction between study condition and familiarity was not significant, $F(2,39) = .46$, $p > .05$. Follow-up Tukey HSD analyses (Kirk, 1982; Marascuilo & Serlin, 1988) revealed that students in the random condition significantly outperformed students in both the standard and non-standard conditions, smallest $t(39) = 2.22$, $p < .05$. See Table 1 for means and standard deviations.

There was no significant difference between the standard and non-standard conditions, $t(39) = .23$, $p > .05$. It appears, then, that allowing students to generate their own structure as was required in the random condition facilitates performance overall relative to the typical presentation orders. In addition, this effect holds true for both familiar and unfamiliar domains.

The typical familiarity effect, with information about familiar animals being remembered more than unfamiliar animals, was found also in this study. The

Table 1. Mean memory performance as a function of familiarity and study condition in Experiment Two

	Familiar	Unfamiliar
Study Condition	Mean (*SD*)	Mean (*SD*)
Random	22.14 (4.26)	14.71 (4.07)
Standard	19.29 (3.79)	10.43 (4.45)
Non-Standard	18.71 (3.89)	10.93 (5.55)

Note. Maximum score = 30 within each familiarity condition.

interaction between familiarity and study condition was not significant, suggesting that the benefit of random presentation was not enough to offset the typical familiarity effect.

One concern with these findings, however, is that the positive effect for the random condition may represent a task-appropriate processing effect (Morris, Bransford, & Franks, 1977). The 60 questions in the memory test were presented randomly to students (consistent with previous research), and hence the structure of the memory test was closer to the study characteristics of the random group (i.e., in this condition, the 60 animals facts were presented randomly during study) than in the standard and non-standard study. Experiment Three was designed to address this issue.

EXPERIMENT 3

In this experiment, we manipulated both the way we presented the study material and the way the memory test was structured. Students were presented the animal facts at study either in a standard or random order (i.e., paralleling the conditions of standard and random in Experiment 2), but half of the students in each condition were presented the memory test questions in a random order and half in a standard order. Four conditions, therefore, were included in this study: standard study/standard memory test, standard study/random memory test, random study/standard memory test, and random study/random memory test.

Method

Participants, design, and procedure

Eighty-eight students (42 men and 46 women) enrolled in a first-year psychology course participated in this experiment. Students were drawn from one university in a mid-sized Canadian city (a different city from Experiment 1 and 2). Students were randomly assigned to one of four different conditions. Forty-four students were assigned to a random order of facts and 44 students were presented with the standard order of items. Within each presentation condition, for the memory test half of the students were tested with items presented in a random order and the other half were tested with sequenced items (i.e., animal by animal). Proportionately equal number of males and females were represented in each condition.

The animal facts used in Experiments 1 and 2 also were presented to students in Experiment 3. Similar to Experiment 2, the standard study conditions contained facts presented in the order listed in Appendix A. The random condition consisted of all 60 facts presented in completely random order. Both orders of presentation contained the same animal facts. After study of the animal facts, students were given the identical memory task as in Experiment 2, with the exception of the students in the standard/standard and random/standard conditions. The students in these two conditions were presented the questions about each animal in a sequenced order (i.e., animal by animal), although the six questions for each animal were presented in a random order (i.e., the questions about each animal were presented in a different order than presentation). In addition, students given the 'standard' order of memory test were not told that the 60 questions presented at test would be arranged according to animal.

Results and discussion

Consistent with previous research examining students' use of the elaborative interrogation strategy (see Willoughby *et al.*, 1994), the transcription of the study session audiotapes confirmed that all students complied with instructions and used their assigned strategy. The memory performance data for the four study conditions were analysed according to the total number of correct responses in the memory test.

A 2 × 2 × 2 repeated measures ANOVA was conducted on the memory test scores with familiarity of the material as the within-subjects variable and study condition (standard, random) and test condition (standard, random) as the between-subjects variables. There was a significant main effect both for familiarity, $F(1,84) = 472.85$, $p < .05$ ($M = 19.38$ (SD 5.94) for familiar animals and 7.28 (5.71) for unfamiliar animals), and study condition, $F(1,84) = 11.69$, $p < .05$ ($M = 30.27$ (10.60) for random and 23.05 (9.04) for standard). There were no other significant differences, largest $F(1,84) = .54$, $p > .05$ for familiarity by study condition.

The findings of Experiment 3 confirm the findings of Experiment 2, suggesting that the positive effect for random presentation found in Experiment 2 was a consequence of the random structure in presentation, rather than an effect of task-appropriate processing. Regardless of how the memory test was structured (random or standard), students who were presented the material randomly during study remembered more facts than students presented the information during study according to animal type.

Table 2. Mean memory performance as a function of familiarity, test and study condition in Experiment Three

Study Condition Test Condition	Familiar Mean (*SD*)	Unfamiliar Mean (*SD*)
Random		
Random Test	20.68 (4.18)	8.23 (4.89)
Standard Test	22.09 (6.69)	9.55 (7.58)
Standard		
Random Test	17.05 (5.78)	5.82 (4.78)
Standard Test	17.68 (5.66)	5.55 (4.38)

Note. Maximum score = 30 within each familiarity condition.

GENERAL DISCUSSION

In this study, if given a choice, students organise the animal facts according to behaviour (e.g., feeding, mating, and habitat) more frequently than they organise by animal, demonstrating that the structure that was provided for them in past research does not necessarily reflect their own preferred way of organising the information. When students have to reconstruct as well as encode the information, these added task demands provide an added benefit for learning. This finding may explain why the random condition significantly promoted learning over the standard condition and why it is important to be aware of students' existing knowledge when using elaborative interrogation. Elaborative interrogation not only depends on the content knowledge but also on how students structure that information. Until this study, investigators looking at elaborative interrogation have been concerned with the familiarity of the materials and how that affects learning. The impact of familiarity on the effectiveness of the elaborative interrogation condition was significant also in this study. It appears, however, that we also must pay attention to how that information is presented to students and whether that organisation is consistent with the learners' knowledge base.

Elaborative interrogation is considered a sophisticated strategy because it involves higher level thinking. The higher level activities include access to existing knowledge structure, making associations between the new material and the existing knowledge, and retrieving that association at a later time. It may be that when first accessing these knowledge structures, elaborative interrogation also implicitly promotes students to invoke other strategic behaviours such as organisation. This might be especially true when the structure of the study materials is not constrained. Previous research supports the suggestion that students asked to employ elaborative interrogation may spontaneously use alternative strategies in addition to elaborative interrogation while studying. For example, students' self-reports indicated that elaborative interrogation also led to the use of imagery, mnemonic, and other sophisticated procedures (Wood, Fler, & Willoughby, 1992). Perhaps, as Siegler (1998) suggests, when a complex strategy is first acquired, it is often used in conjunction with other strategies.

The present study makes clear that both the materials and the students' existing strategic repertoire affect learning. In order to enhance learning, educators need to be sensitive both to the materials that they present and to students' existing strategic knowledge base. Students' application of strategies may be facilitated by explicit instruction about strategies and their uses with specific kinds of materials. In fact, researchers suggest that knowledge about strategies is critical for teaching students how to monitor their learning and become more self-regulated learners (e.g., Pressley, Levin, & Ghatala, 1988). In addition, by enhancing our understanding of when and how strategies work, researchers can better assess the underlying processes of strategic behaviour.

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Appendix A: Example of a familiar and unfamiliar animal set

Western Spotted Skunk (familiar animal)

(1) The Western Spotted Skunk's hole is usually found on a sandy piece of farmland near crops.
(2) The Western Spotted Skunk mostly eats corn.
(3) The Western Spotted Skunk's biggest danger is the Great Horned Owl.
(4) The Western Spotted Skunk lives in a hole in the ground.
(5) The Western Spotted Skunk often lives alone but sometimes stays together in families.
(6) The Western Spotted Skunk is able to live close to people but never be seen.

Collared Peccary (unfamiliar animal)

(1) The Collared Peccary lives in southwestern United States.
(2) The Collared Peccary eats roots and cacti.
(3) The Collared Peccary's biggest dangers are the jaguar and mountain lion.
(4) The Collared Peccary often rests in bushes or under large boulders.
(5) The Collared Peccary has no obvious leaders among its males and females.
(6) The Collared Peccary's stomach has two sections.

Appendix B: Experimental conditions

Standard experimental condition in Experiments 2 and 3

The order of presentation of animals was: Swift Fox, Pronghorn, House Mouse, Little Brown Bat, Chickaree, Townsend Mole, Collared Peccary, Coati, Western Spotted Skunk, American Pika. For each animal set, the six facts were presented in the following order: habitat, diet, source of predation, living environment, social relationships, and unique characteristics.

Non-standard experimental condition in Experiment 2

The order of presentation of animals was identical to the Standard Condition. However, the presentation of the six facts about each animal (i.e., habitat, diet, etc.) was randomised.

Random experimental condition in Experiments 2 and 3

All 60 animal facts were randomised.