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Using prior knowledge to minimize interference when learning large amounts of information

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In three experiments, we examined mediated learning in situations involving learning a large amount of information. Participants learned 144 "facts" during a learning phase and were tested on facts during a test phase. In Experiments 1 and 2, participants learned facts about familiar individuals, unfamiliar individuals, or unfamiliar individuals associated with familiar individuals. Prior knowledge reduced interference, even when it played only a mediating role. In Experiment 3, participants learned facts about unfamiliar individuals or unfamiliar countries, with half the participants in each group associating the unfamiliar items with familiar individuals. Again, use of prior knowledge to mediate learning reduced interference even when the new information was conceptually dissimilar to the previously known information. These results are consistent with the mental model account of long-term memory.

Studies have shown that prior knowledge can have large beneficial effects on learning and memory. For example, in a study by Morris, Gruneberg, Sykes, and Merrick (1981), participants who varied in their knowledge of soccer were presented with scores from a number of different soccer matches and later were asked to recall those scores. Those who possessed more knowledge of soccer recalled more scores. Similarly, in a study by Van Overschelde and Healy (2001), participants were required to learn a large set of domain-irrelevant fabricated facts about 6 baseball players or 6 movie stars, including 12 facts about each person (total of 144). The 144 facts were all unique but were drawn from 12 fact types (e.g., favorite month, type of car driven), so that there was a high degree of similarity across the facts learned. It was found that when the participants had high prior knowledge about the persons, they learned more facts about them than when they had little or no prior knowledge about them, even though the facts were fabricated and domain irrelevant. When the participants had little or no prior knowledge, performance actually decreased across learning rounds, despite increased exposure to the facts in the study phase of each round. This decreased performance across rounds is surprising because performance would be expected to improve as study opportunities increase. However, the proactive and retroactive interference from other items was presumably substantial in this situation because of the large number of items and the high degree of similarity among them. In contrast, when the participants had high prior knowledge, there was no decrease in performance across learning rounds, suggesting that prior knowledge can mitigate interference effects.

There are at least two alternative theoretical accounts for prior knowledge effects, one based on a propositional network and the other on mental models. These accounts have recently been contrasted (Sohn, Anderson, Reder, & Goode, 2004), with support provided for the propositional network account (but see Radvansky, 2005). However, it is not clear how this propositional network account could accommodate the findings of Van Overschelde and Healy (2001), including the surprising decrease in performance across rounds for the case involving low prior knowledge. This account has been focused on the retrieval process rather than the learning process. Those favoring this account (e.g., Anderson, 1983) have argued that prior knowledge effects may arise from higher order processes utilizing long-term memory, which is conceptualized as consisting of nodes and connections between nodes. The nodes represent concepts, whereas the connections represent relationships between concepts. Retrieval entails activating a central cue node, with activation spreading from this central node to all other connected nodes, including the target concept; successful retrieval occurs when the target concept's activation reaches a certain threshold. The number of connections emanating from the central cue node influences retrieval in that, as the number of connections increases, the amount of activation that reaches each associated node decreases. This attenuation might result in an increase in retrieval time (i.e., the *fan effect*; Anderson, 1974), or in retrieval failure if activation failed to reach threshold (i.e., the *cue overload effect*; Watkins & Watkins, 1975).

In contrast, according to the mental model account, representations in long-term memory can be integrated (see, e.g., Johnson-Laird, 1983; Radvansky & Zacks, 1991; van Dijk & Kintsch, 1983). Integration may occur when information is overlearned (Hayes-Roth, 1977), as is the case with experts, or when information is thematic

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(Smith, Adams, & Schorr, 1978), as is the case with domain knowledge. Integrated representations have important beneficial effects on learning and recall. It has been shown that retrieving an item from an integrated representation results in little or no interference (Radvansky & Zacks, 1991). The integration may protect or insulate the new information from interference derived from previous information in memory. The theoretical notion of integration is thus consistent with Van Overschelde and Healy's (2001) observation that interference is reduced when large amounts of new information is learned if that information can be related to a domain of expertise.

Bellezza and Buck (1988) demonstrated that high-knowledge concepts within an integrated representation are effective retrieval cues for domain-irrelevant information. In their study, football experts and clothing experts were presented with pairs of words. One word was either a football term or a clothing term, whereas the other word was a neutral term—a concrete noun—not associated with either domain. Participants were required to create a sentence relating the two words and were subsequently given a cued recall test (in addition to a free-recall test). It was found that on the cued recall test experts recalled more neutral words when these were paired with a word from their domain of expertise. The researchers argued that one reason for this advantage is that when an individual is highly knowledgeable in a given domain, the information is organized hierarchically into an integrated knowledge representation. During recall, individuals can activate this representation, which in turn activates the concepts comprising the knowledge representation. The activated concepts can then serve as retrieval cues for associated domain-irrelevant information.

These earlier studies showing advantages for prior knowledge have involved either experts or at least those with high knowledge of a domain. In the present study, we follow up on these findings to explore whether or not individuals in general can use their everyday knowledge to serve as mediators that can overcome interference such as that exhibited in the study by Van Overschelde and Healy (2001), in which participants were required to learn a large number of related facts.

Indeed, research on mnemonic techniques illustrates that mediators can be used effectively by individuals without any particular expertise in a given domain to improve their ability to learn and retrieve new information. One such mnemonic technique is the method of loci, in which items to be recalled are individually associated with an ordered series of well-known geographical landmarks. At the time of recall, the geographical landmarks serve as retrieval cues for the target concepts. A second mnemonic technique is the peg word method, in which specific words are associated with specific numbers (e.g., one is a bun, two is a shoe, three is a tree, etc.). The associated words serve as the peg words, and, as individuals are presented with items to be recalled, they envision each new item interacting with the next peg word in the series. At recall, the peg words are used as retrieval cues. The two techniques are similar in that both require a preexisting representation stored in long-term memory, and this representation is used to learn new information. Specifically, at the time of encoding, a particular item from this representation is strategically activated and associated with new information; the item is then used as a retrieval cue during recall. Both techniques rely on visual codes, and the items to be recalled need not be semantically or conceptually related to preexisting knowledge for recall to be facilitated. Although these two mnemonics have traditionally been used to improve memory for serial recall (see, e.g., Ross & Lawrence, 1968), they may also improve memory for free recall (Roediger, 1980).

The two mnemonic techniques described are instances of *mediated learning*, a multistep process in which an intervening item is used to cue the recall of the target concept (Adams & McIntyre, 1967; Bellezza, 1986; Bellezza & Poplawsky, 1974; Richardson, 1998). In general, mediated learning has been shown to confer memorial benefits. For example, in a study by Crutcher and Ericsson (2000, Experiment 1), mediators were used in second language vocabulary learning. English-speaking participants were presented simultaneously with Spanish words and their English translations, as well as with keyword mediators; the keyword mediators were concrete English words that were phonologically similar to the Spanish words. The participants were instructed to notice the similarity in sound between the Spanish word and the keyword and to form an interactive image between the keyword and the English translation. It was found that correct translation of the Spanish word was more likely with recall of the keyword mediator. The authors argued that the Spanish word could reliably cue the recall of the keyword mediator because of similar phonology, and the mediator could in turn cue the recall of the English translation via the interactive image.

The primary empirical question addressed in the present study is whether or not mediators can reduce the buildup of interference demonstrated by Van Overschelde and Healy (2001) when participants acquire a large number of highly related facts about unfamiliar individuals, just as expertise was shown to overcome interference in that study. The primary theoretical question considered here is how to account for both the buildup of interference found when facts are learned about unfamiliar individuals and the reduction of such interference that is found with expertise and that may also be found with mediation.

EXPERIMENT 1

Experiment 1 is a follow-up to the study done by Van Overschelde and Healy (2001), in which it is was shown that experts within a given domain learned more facts about persons prominent in their domain of expertise than about those outside their domain of expertise. Van Overschelde and Healy showed that this advantage for high-knowledge concepts was not due simply to familiarity or frequency of exposure to these concepts, but rather to the number of associations to the concepts (i.e., the number of facts associated to each person). This facilitation was interpreted as evidence that experts were able to form an association between these new facts and their prior knowl-

edge. A related question, then, is whether or not individuals can use their prior knowledge to *mediate* the learning of new information. If so, does using prior knowledge as a mediator reduce interference to the same degree as using prior knowledge to learn domain-relevant information? Experiment 1 was undertaken to investigate these issues.

In Experiment 1, participants learned fabricated facts about either familiar or unfamiliar individuals. Half of the participants who learned facts about unfamiliar individuals did so while associating these unfamiliar individuals with persons well-known to them. Performance during a learning phase and during a subsequent test phase was examined.

On the basis of previous research (e.g., Van Overschelde & Healy, 2001), it was predicted that participants who used prior knowledge to learn new facts about well-known individuals would demonstrate more learning than participants who learned facts about unfamiliar individuals. On the basis of previous studies of both mnemonic techniques (e.g., Roediger, 1980) and mediated learning (Crutcher & Ericsson, 2000), participants who associated the unfamiliar individuals with well-known individuals should also demonstrate more learning than participants who did not form such associations. However, mediated learning is thought to involve multiple processing steps (Adams & McIntyre, 1967; Bellezza, 1986; Bellezza & Poplawsky, 1974). At encoding, mediated learning entails retrieving the mediator and associating new information with it; at retrieval, mediated learning entails retrieving the mediator and using it as a retrieval cue for the target concept. On this basis, it was predicted that the participants who used their prior knowledge of familiar individuals to mediate the learning of facts about unfamiliar individuals would demonstrate an intermediate level of performance because of the additional processing demands. An alternative set of predictions follows from the observation that the facts learned about the well-known individuals or about the unfamiliar individuals associated with them are likely to be false (with regard to the well-known individuals) and contradicted by information residing in long-term memory. On the basis of this type of proactive interference (see, e.g., Lewis & Anderson, 1976; Underwood, 1957), an advantage would not be expected either for participants learning facts about well-known individuals or for those learning facts about unfamiliar individuals associated with well-known individuals.

Method

Participants

Thirty-seven introductory psychology students at the University of Colorado participated for course credit; 1 participant was eliminated due to a self-reported learning disability. The remaining 36 participants (10 men and 26 women) were native English speakers. The participants were assigned to conditions by a fixed rotation based on time of arrival to the experiment.

Design

The learning phase of the experiment had a 3 × 3 mixed factorial design. The first variable, knowledge condition, was manipulated between subjects. In the *low knowledge* (LK) condition, participants learned fabricated facts about unfamiliar individuals. In the *mediated knowledge* (MK) condition, participants learned fabricated facts about unfamiliar individuals while associating these unfamiliar individuals with persons well-known to them (e.g., friends, relatives). In the *high knowledge* (HK) condition, participants learned fabricated facts about well-known individuals. The remaining variable, learning round (1–3), was manipulated within subjects. The design of the test phase of the experiment was simpler and included only the between-subjects factor of knowledge condition. The dependent variable examined was the proportion of correct responses.

Materials

A set of 144 fabricated facts, which served as the learning set, was adopted from that used by Van Overschelde and Healy (2001). Each fact was presented as a sentence including person, verb phrase, and fact category exemplar, in that order (e.g., *Linda Hanley drives a BMW*); 12 unique facts were associated with each of 12 individuals. The set of 12 names varied with the between-subjects factor of knowledge condition. In both the LK and MK conditions, the 12 names were of unfamiliar individuals drawn from the domains of professional beach volleyball and off-Broadway plays; in the HK condition, the 12 names were of individuals well-known to the participant. Each of the 12 verb phrases uniquely identified one of the fact categories and was one to four words in length (*Mdn* = 2.67). The fact category exemplars, each one word in length, were common instances of the fact category. See Appendix A for a list of all facts involving unfamiliar individuals used in Experiment 1.

Procedure

Listing procedure/association training. For all the participants, the experiment began with a listing procedure, during which they were required to type the names (first and last) of 12 individuals (6 female, 6 male) with whom they were well acquainted (e.g., friends and relatives). After the listing procedure, the participants in the MK condition completed association training, whereby they were trained to associate (by any means) the names of the 12 individuals they had listed during the listing procedure with the names of the 12 unfamiliar individuals used in the learning set through a paired-associate learning task. Specifically, the name of each unfamiliar individual was paired with the name of a familiar individual, matched for gender, and the 12 resulting familiar–unfamiliar name pairs were presented, one at a time, on the computer screen for 2.5 sec. After the set of 12 familiar–unfamiliar name pairs had been presented, the participants were tested over all 12 pairs, in a different order than during presentation, in a cued recall test. For the test, the participants were provided with the unfamiliar name and required to generate and type the associated familiar name. This learn–test cycle was repeated in different orders until the participants reached a criterion of three consecutive cycles with perfect accuracy, at which point they proceeded to the learning phase of the experiment. The participants in the LK and HK conditions bypassed association training; after the listing procedure, the participants in these two groups proceeded directly to the learning phase of the experiment.

Learning phase. Following the listing procedure (LK and HK conditions) or association training (MK condition) was the learning phase, during which the participants were presented with 12 fabricated facts about each of 12 individuals, for a total of 144 facts. In the LK and MK conditions, the facts described the 12 unfamiliar individuals; in the HK condition, the facts described the 12 individuals named during the listing procedure at the beginning of the experiment. The participants in the MK condition received the extra instruction that, while each fact was being presented, they were to recall the associated familiar name. This instruction manipulation was intended to help them associate each fact presented with the unfamiliar person. Facts were presented individually for 3 sec, in blocks of 12. The set of 12 facts presented within a block was constrained in that, within each block, 1 fact was presented about each of the 12 individuals and each of the 12 fact categories was used once. After each block, there was a cued recall test on the 12 facts presented in the block. During each test, cues were also presented individually, in the same order in which the facts were presented, and each cue consisted of name and verb phrase followed by a blank (e.g., *Linda Hanley drives a _____?*). Thus, the participants had to respond by typing the fact category exemplar. The participants were instructed that if they could not remember the fact category exemplar they could press the "return" key to advance to the next question, and that the test would automatically advance after 8 sec if they did not initiate a typing response. The

presentation and testing of the 144 facts constituted one learning round. The participants completed three learning rounds, so that each fact was presented and tested three times. The 12 facts presented within a block were held constant, but the blocks and the facts within each block were presented in different orders for each of the three learning rounds and the final test round, thereby discouraging a serial-order mnemonic strategy.

Final test phase. Following the learning phase was the final test phase, during which the participants were tested on all 144 facts. The set of 12 facts presented within a block was the same as that presented in the learning phase, but it was presented in a new, pseudorandom order. Thus, within each set of 12 facts, each individual and each fact category was tested once, and the participants were tested by cued recall.

Results and Discussion

Learning Phase

The analysis of accuracy during the learning phase revealed a main effect of knowledge condition [$F(2,33) = 6.32$, $MS_e = 0.068$, $p < .01$; $\eta^2 = .277$]. On average, accuracy was highest for the HK condition ($M = .786$) and lowest for the LK condition ($M = .568$), with the MK condition intermediate ($M = .679$). A planned contrast between the LK and HK conditions revealed a significant difference between them [$F(1,33) = 4.19$, $MS_e = 0.068$, $p < .05$; $\eta^2 = .113$]. This result replicates the general finding that prior knowledge can facilitate the learning of new information (Van Overschelde & Healy, 2001). To address the issue of whether or not prior knowledge can be used to mediate the learning of new information, a planned comparison of the LK and MK conditions was performed. This analysis showed that there was a marginally significant trend for accuracy to be higher for the MK condition [$F(1,33) = 3.28$, $MS_e = 0.068$, $p = .08$; $\eta^2 = .091$]. Thus, to some extent, using prior knowledge to mediate the acquisition of new information increases the amount learned. This result is interesting in light of the many studies that have demonstrated domain specificity in learning (e.g., Chase & Simon, 1973). In contrast, this result shows that prior knowledge can facilitate the learning of new information, even if it is not related to the domain of the prior knowledge. To address the issue of whether or not the facilitative effect of mediated learning is equivalent to that of domain-relevant learning, a planned comparison of the MK and HK conditions was performed. This analysis showed that accuracy was somewhat greater for the HK condition than for the MK condition, although this difference was only marginally significant [$F(1,33) = 3.03$, $MS_e = 0.068$, $p = .09$; $\eta^2 = .084$]. That accuracy was somewhat lower for the MK condition than for the HK condition suggests that the facilitative effect of using prior knowledge to learn new information depends on whether prior knowledge plays a direct or a mediating role; the effect appears to be somewhat greater when new information is directly related to prior knowledge, as in the HK condition, than when prior knowledge serves only a mediating function, as in the MK condition. In any event, the advantage for the MK and HK conditions relative to the LK condition is especially impressive considering that for both of the former conditions, new information may be contradicted by prior knowledge, resulting in proactive interference (Lewis & Anderson, 1976; Underwood, 1957).

On average, accuracy did not increase across learning rounds ($F < 1$); however, knowledge condition interacted with learning round, indicating that performance across learning rounds differed between knowledge conditions [$F(4,66) = 2.66$, $MS_e = 0.007$, $p = .04$; $\eta^2 = .139$; see Figure 1]. Interestingly, performance decreased monotonically for the LK condition, remained stable for the MK condition, and generally improved for the HK condition. Further analysis showed that only the improvement for the HK condition was statistically significant [for HK, $F(2,22) = 4.03$, $MS_e = 0.003$, $p = .03$, $\eta^2 = .268$; for MK, $F(2,22) = 1.02$, $MS_e = 0.009$, $p = .38$, $\eta^2 = .085$; for LK, $F(2,22) = 1.75$, $MS_e = 0.010$, $p = .20$, $\eta^2 = .137$]. The (nonsignificant) decrease in accuracy across learning rounds for participants in the LK condition resembles that found for the analogous condition in the study by Van Overschelde and Healy (2001) and is unusual given the repeated study, but it can be explained in terms of a build-up of interference. Specifically, it is assumed that the participants in this condition used unfamiliar individuals as retrieval cues. Thus, as the experiment progressed and more facts became associated with each unfamiliar individual, the participants experienced a cue overload effect (Watkins & Watkins, 1975). In contrast, the participants in the MK and HK conditions were able to use prior knowledge to learn new facts. Given the previous account of domain-relevant and mediated learning, it is assumed that the participants in these two conditions were able to integrate new information into their preexisting representations, thereby moderating interference effects (Radvansky, 1998, 1999).

Final Test Phase

At test, the main effect of knowledge condition was significant [$F(2,33) = 10.89$, $MS_e = 0.045$, $p < .01$; $\eta^2 = .398$]. As in the learning phase, accuracy was highest for the participants in the HK condition ($M = .610$), lowest for those in the LK condition ($M = .216$), and intermediate for those in the MK condition ($M = .486$). Note that accuracy for the MK condition was more than twice that for the LK condition. Thus, unlike in the learning phase, accuracy was significantly higher for the MK condition than for the LK condition [$F(1,33) = 9.73$, $MS_e = 0.045$, $p < .01$; $\eta^2 = .228$] and was numerically (but not significantly) higher for the HK condition than for the MK condition [$F(1,33) = 2.07$, $MS_e = 0.045$, $p = .16$; $\eta^2 = .059$]. Thus, prior knowledge benefits retention even when it plays only a mediating role; despite the multiple processing steps required, mediated learning resulted in a significant benefit relative to learning the same information with no mediators.

Summary

Like Van Overschelde and Healy (2001), we found an advantage for the HK condition relative to the LK condition during both learning and testing. This advantage could be due to the relative familiarity of the cues rather than to the amount of knowledge associated with each cue. However, this explanation seems unlikely given Van Overschelde and Healy's demonstration that, when the

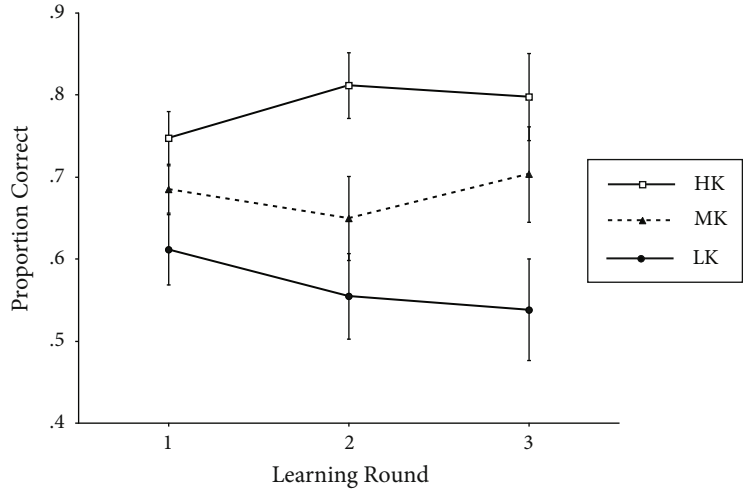

Figure 1. Proportion correct during the learning phase as a function of learning round and knowledge condition in Experiment 1. Bars indicate standard errors of the mean. HK, high knowledge; MK, mediated knowledge; LK, low knowledge.

amount of knowledge and frequency of exposure to cues were varied orthogonally, only the amount of knowledge had an impact on learning.

The primary purpose of Experiment 1 was to show that using prior knowledge to mediate the learning of new information improves recall of this information. It was found that mediated learning did confer an advantage, as is evidenced by the advantage for the MK condition relative to the LK condition. During learning, participants in the LK condition showed a (nonsignificant) decline in performance as a function of learning round, whereas those in the MK condition did not show this pattern of interference. Furthermore, during the final test phase of the experiment, participants in the MK condition significantly outperformed those in the LK condition. From previous accounts of mediated learning (e.g., Bellezza, 1986), it is assumed that when the participants in the MK condition were presented with facts to learn about unfamiliar individuals, they used the unfamiliar individuals as cues to activate their representations of the associated familiar individuals. These participants were then able to elaborately encode the items—in other words, to integrate the new facts into the representations of the familiar individuals. Elaborate encoding and integration minimize the negative effects of interference, which is why the MK condition showed less evidence of interference across learning rounds than did the LK condition.

A secondary purpose of the experiment was to make a direct comparison between mediated learning and domain-relevant learning. It was found that there was a somewhat greater advantage for domain-relevant learning during the learning phase, and a numerical (but nonsignificant) advantage during the final test phase. As we stated previously, encoding in mediated learning is thought to involve two processing steps, in which individuals first retrieve the mediator and subsequently associate new information to it (see, e.g., Bellezza, 1986). Thus, the worse performance of the participants in the MK condition might be the result of failure at either of these steps. More specifically, the participants in the MK condition might have been unable to reliably recall the names of the associated familiar individuals and therefore unable to use their prior knowledge of familiar individuals to aid learning. Alternatively, the participants in the MK condition might have been able to reliably recall the associated familiar individual but unable to consistently associate the new fact with the familiar individual. A third possibility is that the result is a combination of both factors. Whatever the reason may be, because the participants in the MK condition were not always able to use prior knowledge, they showed more interference across learning rounds than did those in the HK condition, presumably reflecting some degree of interference. One way to distinguish between these alternatives would be to extend (1) association training for participants in the MK condition, which would enable them to more reliably recall the names of associated familiar individuals and (2) the presentation time of the facts, which in turn would allow them to elaborately encode the items to be learned. The possibility remains that multistep cognition, as in mediated learning, entails some cost, and that there would still be an advantage for domain-relevant learning.

However, the conclusion that prior knowledge can mediate learning is undermined by the presence of a confounding variable—specifically, name familiarity. The participants in the MK condition, but not those in the LK condition, became familiar with the names of the unfamiliar individuals used in the learning set by virtue of having completed association training. Thus, it is possible that the advantage for the MK condition relative to the LK condition was due to familiarization with the names of the unfamiliar individuals, and that familiarizing the participants in the LK condition with the names of the unfamiliar individuals would eliminate the advantage. The purpose of Experiment 2, then, was to examine mediated learning after controlling for this confounding variable.

EXPERIMENT 2

In this experiment, the between-subjects manipulation of knowledge condition was retained. However, because the critical difference lies between the LK and MK conditions, the HK condition was eliminated. Participants in both the LK and MK conditions completed association training, and the number of association training rounds was fixed. Thus, the two conditions were equated in terms of frequency of exposure to the names of the unfamiliar individuals. If using prior knowledge as a mediator facilitates learning, then the advantage for the MK condition should remain even after correction for the confounding variable.

Method

Participants

Twenty-five introductory psychology students at the University of Colorado participated for course credit; 1 participant was eliminated due to a self-reported learning disability. The remaining 24 participants (12 men and 12 women) were all native English speakers. The participants were assigned to conditions by a fixed rotation based on time of arrival to the experiment.

Design

The design of Experiment 2 was the same as that of Experiment 1, with two exceptions. First, the between-subjects variable of knowledge condition had only two levels (LK and MK). Second, performance during association training was analyzed in Experiment 2. The design of association training was a 2×8 mixed factorial design; the first variable was knowledge condition, and the second variable was association training round (1–8), which was manipulated within subjects. As in Experiment 1, the dependent variable examined was the proportion of correct responses.

Materials

The set of 144 fabricated facts used in Experiment 1 was again used in Experiment 2 (see Appendix A). In addition, the names of 12 memory researchers, presumably unfamiliar to the participants at the time of the experiment, were used during association training for the LK condition (see Appendix B).

Procedure

The procedure was the same as in Experiment 1, with the following modifications: After the listing procedure, the participants in both the LK and MK conditions completed association training. As in Experiment 1, those in the MK condition associated the names of 12 familiar individuals with the names of 12 unfamiliar individuals, whereas the participants in the LK condition associated the names of 12 memory researchers with the names of 12 unfamiliar individuals. The number of association training rounds was fixed at eight. Thus, after completing eight rounds of association training, the participants in both conditions continued to the learning phase of the experiment. Before the learning phase, the participants were instructed that, while each fact was being presented, it might help to recall the name of the associated memory researcher (LK condition) or the name of the associated familiar individual (MK condition).

Results and Discussion

Association Training

On average, the participants in the MK condition correctly recalled a larger proportion of associations (M = .848) than did the participants in the LK condition (M = .331) [$F(1,22) = 64.95$, $MS_e = 0.198$, $p < .01$; η^2 = .747]. Across association training rounds, the proportion of correctly recalled associations increased monotonically [$F(7,154) = 49.70$, $MS_e = 0.017$, $p < .01$; $\eta^2 = .693$]. However, the learning of associations across association training rounds differed between the two knowledge conditions [$F(7,154) = 5.51$, $MS_e = 0.017$, $p < .01$; η^2 = .200]. For the participants in the LK condition, performance increased monotonically across training rounds, whereas for those in the MK condition performance reached an asymptote, near ceiling-level performance, after the fifth training round (see Figure 2). Subsequent analysis revealed a significant increase across rounds in both the LK condition [$F(7,77) = 27.90$, $MS_e = 0.023$, $p < .01$; $\eta^2 = .717$] and the MK condition [$F(7,77)$ = 27.04, $MS_e = 0.012$, $p < .01$; $\eta^2 = .711$].

Learning Phase

During the learning phase, there was a main effect of knowledge condition [$F(1,22) = 5.52$, $MS_e = 0.064$, p = .03; $\eta^2 = .201$]. On average, accuracy was greater for the MK condition (M = .719) than for the LK condition (M = .579). Thus, as in Experiment 1, using prior knowledge to mediate the learning of new information led to superior performance during the learning phase. Furthermore, this learning advantage is attributable solely to the use of prior knowledge and is not caused by familiarity with the names used in the learning set.

Overall, accuracy did not improve across learning rounds [$F(2,44) = 1.48$, $MS_e = 0.010$, $p = .24$; $\eta^2 = .063$]. However, learning round interacted with knowledge condition, indicating that learning patterns differed between the two conditions [$F(2,44) = 11.71$, $MS_e = 0.010$, $p < .01$; η^2 = .347; see Figure 3]. For the MK condition, accuracy increased over the three learning rounds [$F(2,22) = 4.04$, $MS_e = 0.008$, $p = .03$; $\eta^2 = .269$], whereas accuracy actually decreased over the three learning rounds for the LK condition [$F(2,22) = 8.19$, $MS_e = 0.013$, $p < .01$; η^2 = .427] despite the repeated study. Again, this result replicates the finding of negative learning for the participants in the LK condition, as well as the conclusion that using prior knowledge as a mediator minimizes the negative effects of interference.

Final Test Phase

The analysis of the final test phase revealed a main effect of knowledge condition [$F(1,22) = 8.43$, MS_e = 0.073, $p < .01$; $\eta^2 = .28$]. As in Experiment 1, accuracy was more than twice as great for the participants in the MK condition (M = .514) as for those in the LK condition (M = .193), again suggesting that mediated learning strongly benefits retention.

Summary

The results of Experiment 2 largely replicate the findings of Experiment 1. Again, it was shown that prior knowledge can effectively mediate learning, as is evidenced by the advantage for the MK condition relative to the LK condition for both the learning and final test phases of the experiment. Thus, the facilitative effect of mediated learning found in Experiment 1 was not caused by familiarity with the names used in the learning set. Rather, this advantage seems to be conferred specifically by the use of prior knowledge and might be described as a reduction in the amount of interference.

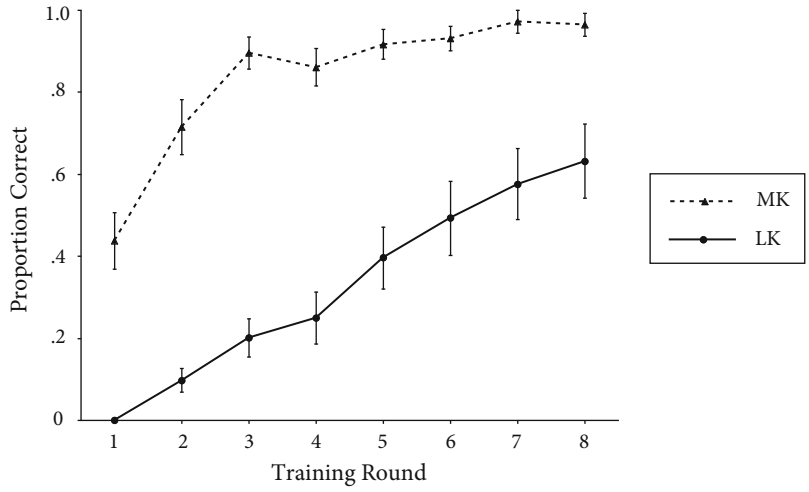

Figure 2. Proportion correct during association training as a function of training round and knowledge condition in Experiment 2. Bars indicate standard errors of the mean. MK, mediated knowledge; LK, low knowledge.

EXPERIMENT 3

Experiments 1 and 2 demonstrated that prior knowledge can effectively mediate the learning of domain-irrelevant information. However, in both Experiments 1 and 2 prior knowledge was used to learn information that was conceptually similar to it. In other words, the participants used their knowledge of people to learn about people. The purpose of Experiment 3 was to investigate the flexibility of prior knowledge in mediated learning—that is, to determine whether or not prior knowledge can be used to learn information that is both domain irrelevant *and* conceptually unrelated. Furthermore, if prior knowledge can mediate the learning of conceptually unrelated information, there remains the question of whether or not this facilitative effect is comparable to that obtained when prior knowledge is used to mediate the learning of conceptually similar information.

To examine these issues, the participants in Experiment 3 learned true information about unfamiliar countries or fabricated facts about unfamiliar individuals. Half of the participants in each group were trained to associate the names of well-known individuals with the names of these unfamiliar countries or unfamiliar individuals. The type of test employed during the learning and final test phases was changed to a cued recognition test in order to prevent accuracy from approaching the floor, because the fact category exemplars used in the learning set were presumed to be unfamiliar to the participants. Thus, an additional group of participants was included in order to examine whether or not the results for the HK condition of Experiment 1 generalize to recognition tests. Finding the same effects

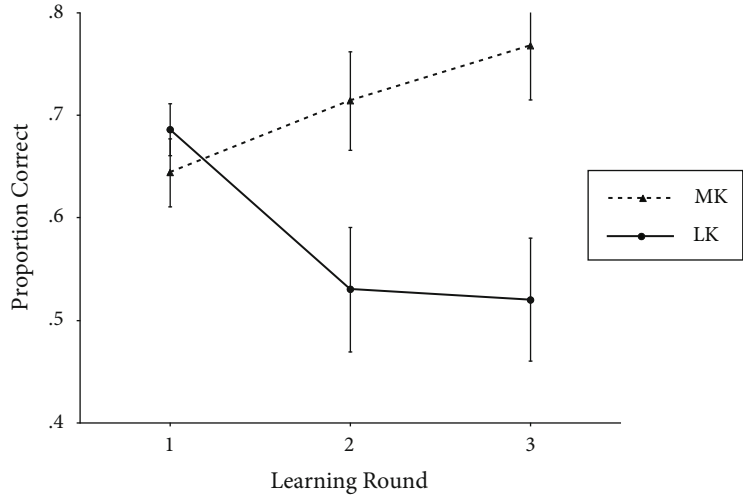

Figure 3. Proportion correct during the learning phase as a function of learning round and knowledge condition in Experiment 2. Bars indicate standard errors of the mean. MK, mediated knowledge; LK, low knowledge.

with recognition tests would greatly enhance the external validity of the results, especially given the fact that previous studies have shown many different effects for recall and recognition tests (e.g., Long & Prat, 2002). Participants in this HK condition learned fabricated facts about well-known individuals, which allowed for a comparison of domain-relevant and mediated learning on recognition tests.

Method

Participants

Sixty introductory psychology students at the University of Colorado (17 men and 43 women) participated for course credit. All were native English speakers and free of learning disabilities. The participants were assigned to conditions by a fixed rotation based on time of arrival to the experiment.

Design

Four between-subjects groups were formed by crossing two variables. The first variable was domain; participants in the *country* group learned 12 true facts about each of 12 unfamiliar countries, whereas participants in the *person* group learned 12 fabricated facts about each of 12 unfamiliar individuals. The second variable was knowledge condition. In the LK condition, participants learned facts about unfamiliar countries or unfamiliar individuals, whereas in the MK condition participants learned facts about unfamiliar countries or unfamiliar individuals while associating these countries or individuals with persons well-known to them. In addition to the four groups formed by crossing these two variables, another group was included in Experiment 3. The participants in this group learned 12 fabricated facts about each of 12 well-known individuals; this group was therefore designated the *HK person* group.

The design of association training was a 2×8 mixed factorial design, with the between-subjects factor of domain (country vs. person) and the within-subjects factor of association training round (1–8). Association training was limited to those participants in the MK condition and was fixed in length at eight training rounds, as in Experiment 2.

For the learning phase, there were two different designs. The first was a $2 \times 2 \times 3$ mixed factorial, with the HK person group excluded from analysis. There were two between-subjects factors (domain: country vs. person; knowledge condition: LK vs. MK) and one within-subjects factor (learning round: 1 vs. 2 vs. 3). The corresponding design of the final test phase retained the between-subjects factors of domain and knowledge condition. This design allowed for a comparison of conceptually similar and conceptually unrelated mediated learning.

The second design was a 3×3 mixed factorial design, with the country groups excluded from analysis. Thus, there was a between-subjects factor of knowledge condition (LK vs. MK vs. HK) and a within-subjects factor of learning round (1 vs. 2 vs. 3). The corresponding design of the final test phase included only the between-subjects factor of knowledge condition. This design replicated that of Experiment 1 and allowed for a comparison of domain-relevant learning and mediated learning on recognition tests. As in the previous two experiments, accuracy was examined.

Materials

Two sets of 144 facts were created for use in this experiment. The first set of facts was used for the country groups, in which the participants learned real facts about countries. Unlike in Experiments 1 and 2, the facts associated with a given individual or country were not all unique in that, for 5 of the 12 fact categories, one or two exemplars were used more than once, because true information was employed (see Appendix C for the facts used in Experiment 3). In the first set, each fact was presented as a sentence including country, verb phrase, and fact category exemplar, in that order (e.g., *Rwanda's capital city is Kigali*); 12 facts were associated with each of 12 countries. The names of the 12 countries were selected so as to be relatively unfamiliar to the participants. Each of the 12 verb phrases uniquely identified 1 of the fact categories and was two to four words in length (*Mdn* = 3.00). The fact categories were primarily demographic and geographic characteristics of countries, and the fact category exemplars were each one to three words in length (*Mdn* = 1.00). All facts in this set were accurate and drawn from the World FactBook (n.d.).

The second set of facts was used for the person groups, in which the participants learned fabricated facts about individuals. As with the first set, each fact was presented as a sentence including person, verb phrase, and fact category exemplar, in that order (e.g., *Gina Ferrall's favorite city is Kigali*); 12 facts were associated with each of 12 individuals. The set of 12 names varied; for the LK and MK conditions, the 12 unfamiliar names used in Experiments 1 and 2 were used again, and in the HK condition the 12 names were those of individuals known to the participant. Each of the 12 verb phrases uniquely identified one of the fact categories and was one to six words in length (*Mdn* = 3.00). The fact categories and exemplars were matched to those used in the country groups. For example, one fact category in the country groups is "capital city," whereas in the person groups the corresponding fact category is relabeled as "favorite city." Thus, the same set of fact category exemplars was used for both the country and person groups, although they fell under different fact categories.

Procedure

Pretest/listing procedure/association training. For participants in the country groups, the experiment began with a pretest to assess their prior knowledge of the facts used in the learning set. Each participant in these two groups was provided with a sheet of paper containing a 13×13 matrix. On the left side of the matrix, the names of the 12 countries used in the learning set were listed vertically, and across the top of the matrix, the names of the 12 fact categories were listed horizontally. The participants were instructed to fill out the matrix to the best of their ability. After the pretest, the participants in the country groups advanced to the listing procedure. The participants in the person groups skipped the pretest; instead, for them the experiment began with the listing procedure. As in Experiments 1 and 2, during the listing procedure the participants in each of the five groups listed the names (first and last) of 12 individuals (6 female, 6 male) with whom they were acquainted. After the listing procedure, the participants in the MK condition only completed association training. In the MK person group, the participants were trained to associate the names of the 12 individuals they had listed with the names of the 12 unfamiliar individuals used in the learning set, matched for gender. In the MK country group, the participants were trained to associate the names of the 12 individuals they had listed with the names of the 12 countries used in the learning set. Association training proceeded as in Experiment 2, with the number of association training rounds fixed at eight. After association training, the participants in the MK condition proceeded to the learning phase. The participants in the other three groups (LK country, LK person, and HK person) did not complete association training; after the listing procedure, the participants in these three groups began the learning phase.

Learning phase. The learning phase was the same as in Experiments 1 and 2, with two exceptions. First, before starting the learning phase, all the participants were provided with a list containing all fact category exemplars, organized by fact category and arranged in alphabetical order. The participants were told that they could refer to the sheet when being tested, and thus the tests were changed to cued recognition tests. Second, each fact was displayed for 3.5 sec (instead of 3 sec), and the participants were given 12 sec (instead of 8 sec) to respond before the program automatically advanced to the next question. The former timing change was made because the fact category exemplars were less familiar than those used in Experiments 1 and 2, and the latter timing change was made to allow the participants sufficient time to refer to the list of fact category exemplars before the program automatically advanced. The participants in the MK condition received the extra instruction that while each fact was being presented, they were to recall the familiar name associated with the individual (person group) or country (country group).

Final test phase. The final test phase was the same as in Experiments 1 and 2, except that the test was changed to a cued recognition test and the participants were allowed 12 sec to respond before the program automatically advanced to the next question, as was the case during the learning phase.

Results and Discussion

Pretest

The analysis of the proportion of correct items on the pretest was restricted to the two country groups. This analysis

revealed no significant difference between the proportions of facts known before the experiment in the LK condition (M = .014) and in the MK condition (M = .017) ($F < 1$). In both cases, fewer than 2% of the facts were known in advance.

Association Training

The analysis of the proportion of associations correctly recalled during association training was restricted to the MK condition. There was a main effect of training round [$F(7,154) = 40.69$, $MS_e = 0.008$, $p < .01$; $\eta^2 = .649$], with accuracy improving across the first three training rounds and reaching ceiling-level performance in both groups after the fourth training round (.660, .854, .924, .955, 1.000, .997, 1.000, and 1.000 for Rounds 1–8, respectively).

Analyses From Which the HK Person Group Was Excluded

Learning phase. The analysis of accuracy during the learning phase revealed a main effect of knowledge condition [$F(1,44) = 14.18$, $MS_e = 0.058$, $p < .01$; $\eta^2 = .243$]. Overall, accuracy was greater for the MK condition (M = .820) than for the LK condition (M = .668); thus, there was a general facilitative effect of mediated learning. In addition, accuracy was slightly higher for the country groups (M = .780) than for the person groups (M = .707), but the effect of domain did not reach standard levels of significance [$F(1,44) = 3.30$, $MS_e = 0.058$, $p = .08$; η^2 = .069]. However, knowledge condition and domain interacted, reflecting the fact that the effectiveness of mediated learning depended on domain [$F(1,44) = 7.04$, MS_e = 0.058, $p = .01$; $\eta^2 = .137$] (see Figure 4). This interaction arises because there was a greater positive effect of mediated learning in the person domain than in the country domain, which suggests that mediated learning is more effective when prior knowledge is conceptually similar to new information. The result makes intuitive sense; it seems likely that it is more difficult to associate new information to prior knowledge when the two are conceptually different than when they are conceptually similar. An alternative interpretation of the interaction is that it is driven by the fact that the performance of the LK country group was unusually good. However, it seems to be the case that certain facts were easier to learn for the country groups than for the person groups. For example, one fact to be learned in the country domain is that Bahrain's most prevalent ethnic group is Bahraini, whereas in the person domain, the equivalent fact was that Yvette Freeman's ethnicity is Bahraini. The relatively easier task of learning these types of items in the country group also explains the numerical advantage for country groups (although the main effect of domain was not statistically significant). However, assuming that the LK and MK country groups benefited to the same extent, then the interaction still implies that conceptually similar mediated learning confers a larger benefit than does conceptually unrelated mediated learning. Additional analyses showed that the difference between the LK and MK conditions, or the effect of mediated learning, was significant in the person domain

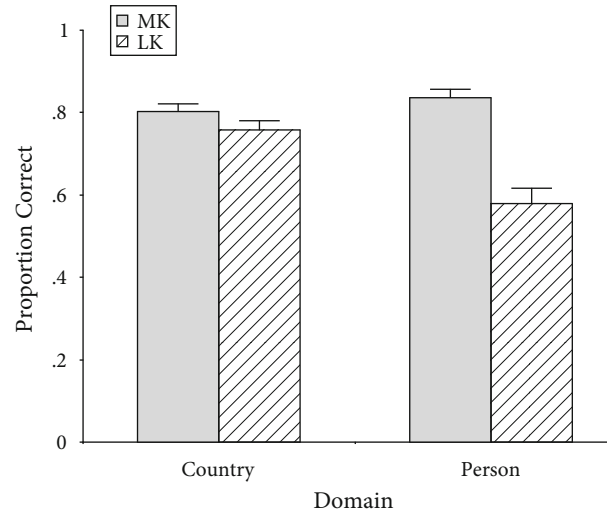

Figure 4. Proportion correct during the learning phase as a function of knowledge condition and domain in Experiment 3. The HK person group was excluded from the analysis. Bars indicate standard errors of the mean. MK, mediated knowledge; LK, low knowledge.

[$F(1,44) = 20.60$, $MS_e = 0.058$, $p < .01$; $\eta^2 = .319$] but not in the country domain ($F < 1$).

On average, there was a trend for performance to decrease across learning rounds [Ms = .768, .741, and .723 for Rounds 1–3, respectively; $F(2,88) = 2.84$, MS_e = 0.009, $p = .06$; $\eta^2 = .060$]. However, an interaction between knowledge condition and learning round [$F(2,88)$ = 4.10, $MS_e = 0.009$, $p = .02$; $\eta^2 = .085$] showed that accuracy decreased across learning rounds only in the LK condition [$F(2,44) = 5.39$, $MS_e = 0.011$, $p < .01$; $\eta^2 = .197$]; performance remained stable across learning rounds in the MK condition ($F < 1$) (see Figure 5). This pattern is similar to that obtained in Experiments 1 and 2 and is again interpreted as evidence that using prior knowledge as a mediator moderates the negative effects of interference.

Final test phase. At test, there was a main effect of knowledge condition [$F(1,44) = 33.74$, $MS_e = 0.040$, $p < .01$; $\eta^2 = .434$] as well as a main effect of domain [$F(1,44) = 4.23$, $MS_e = 0.040$, $p < .05$; $\eta^2 = .087$]. These main effects arose because performance was more than twice as high for the MK condition (M = .643) as for the LK condition (M = .308), reflecting a strong beneficial effect of mediated learning, and performance was better for the country groups (M = .535) than for the person groups (M = .416), perhaps because some items were easier to learn in the country groups. The interaction between knowledge condition and domain was not significant [$F(1,44)$ = 1.19, $MS_e = 0.040$, $p = .28$; $\eta^2 = .026$]. Additional analyses showed that the advantage for the MK condition relative to the LK condition was significant in both the person domain [$F(1,44) = 23.79$, $MS_e = 0.040$, $p < .01$; η^2 = .351] and the country domain [$F(1,44) = 11.12$, MS_e = 0.040, $p < .01$; $\eta^2 = .202$] (see Figure 6). This result suggests that conceptually unrelated mediated learning can be used to benefit memory for new information.

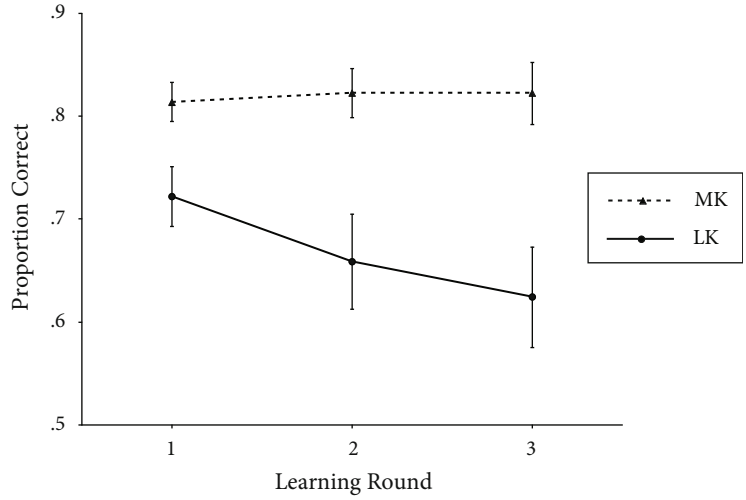

Figure 5. Proportion correct during the learning phase as a function of learning round and knowledge condition in Experiment 3. The HK person group was excluded from the analysis. Bars indicate standard errors of the mean. MK, mediated knowledge; LK, low knowledge.

Analyses From Which the Country Groups Were Excluded

Learning phase. During learning, there was a main effect of knowledge condition [$F(2,33) = 13.15$, $MS_e = 0.057$, $p < .01$; $\eta^2 = .443$], with accuracy similar for the MK ($M = .836$) and HK ($M = .821$) conditions but lower for the LK ($M = .579$) condition. Planned comparisons showed that the difference between the LK and MK conditions was significant [$F(1,33) = 20.94$, $MS_e = 0.057$, $p < .01$; $\eta^2 = .388$]. Thus, the facilitative effect of mediated learning replicates on recognition tests. Perhaps more interestingly, a second planned comparison of the MK and HK conditions revealed no significant difference ($F < 1$); accuracy was actually numerically greater in the MK condition than in the HK condition. This result does suggest that mediated and domain-relevant learning *can* confer equivalent benefits when testing is done by recognition, but not that this is always the case. It was suggested in Experiment 1 that extending association training and increasing the presentation time of facts might eliminate the difference between the MK and HK conditions. In this experiment, the participants in the MK condition were at or near ceiling-level performance for approximately four training rounds during association training, and fact presentation time was increased by 0.5 sec. Consequently, performance in the MK condition was at least as good as that in the HK condition during learning.

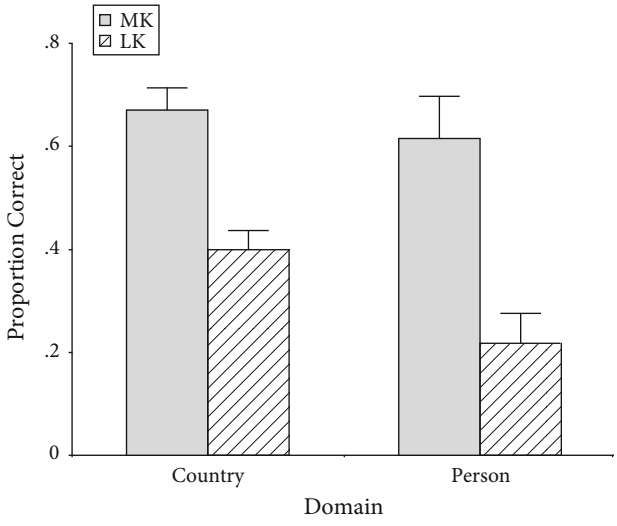

Figure 6. Proportion correct during the final test phase as a function of knowledge condition and domain in Experiment 3. The HK person group was excluded from the analysis. Bars indicate standard errors of the mean. MK, mediated knowledge; LK, low knowledge.

This analysis also revealed a main effect of learning round [$F(2,66) = 3.76$, $MS_e = 0.009$, $p = .03$; $\eta^2 = .102$], with accuracy decreasing across the first two learning rounds ($M = .779$, .723, and .734 for Rounds 1–3, respectively). Knowledge condition interacted with learning round [$F(4,66) = 3.19$, $MS_e = 0.009$, $p = .02$; $\eta^2 = .162$]. Across learning rounds, performance remained relatively level for the MK condition ($F < 1$) and the HK condition [$F(2,22) = 3.02$, $MS_e = 0.004$, $p = .07$; $\eta^2 = .321$]; however, accuracy decreased across learning rounds for the LK condition [$F(2,22) = 5.21$, $MS_e = 0.015$, $p = .01$; $\eta^2 = .215$] (see Figure 7). This interaction again supports the conclusion that prior knowledge moderates the effects of interference.

Final test phase. At test, there was a main effect of knowledge condition [$F(2,33) = 12.13$, $MS_e = 0.050$, $p < .01$; $\eta^2 = .424$]. As in the learning phase, accuracy was as high for the MK condition ($M = .615$) as for the HK condition ($M = .599$) but less than half as high for the LK condition ($M = .217$). Planned comparisons showed that accuracy was significantly greater for the MK condition than for the LK condition [$F(1,33) = 18.73$, $MS_e =$

0.050, $p < .01$; $\eta^2 = .362$] and numerically (but not significantly) greater for the MK condition than for the HK condition ($F < 1$).

Summary

Experiment 3 was conducted to assess whether or not prior knowledge can mediate the learning of facts that are both domain irrelevant and conceptually unrelated to prior knowledge and, if so, whether or not this effect is equivalent to that obtained when prior knowledge mediates the learning of facts that are just domain irrelevant. To that end, the participants in this experiment learned facts about unfamiliar countries or facts about unfamiliar individuals, with half of the participants in each group associating the countries or individuals with familiar individuals. During the learning phase, it was shown that the advantage for the MK condition was significantly greater in the person group than in the country group. Furthermore, in the person domain there was a significant advantage for the MK condition, whereas in the country domain the advantage for the MK condition was nonsignificant. However, during the final test phase the advantage for the MK condition was significant in both the person domain and the country domain. These results suggest that prior knowledge can indeed mediate the learning of conceptually unrelated information. In addition, both unrelated and related prior knowledge were shown to reduce interference during learning.

In Experiment 3, the participants were tested with a cued recognition test, and so an additional group of participants was included to examine whether or not the results of the previous two experiments would replicate on recognition tests. During both the learning and final test phases of the experiment, an advantage was found for the MK condition relative to the LK condition, and the MK condition showed less evidence of interference across learning rounds. These results are similar to those of Experiments 1 and 2. The second key issue was whether or not the difference between the MK and HK conditions found in Experiment 1 would also replicate with recognition tests. In this experiment, there was no difference between the two conditions during the learning and final test phases, and both conditions seemed equally resistant to the effects of interference during the learning phase. Thus, at least on recognition tests, mediated learning can be as effective as domain-relevant learning.

GENERAL DISCUSSION

The primary objective of this study was to systematically examine the extent to which prior knowledge can be used to mediate the learning of new information in a situation involving the learning of a large amount of information. Previous research (Van Overschelde & Healy, 2001) has shown that in such situations learning actually declines across successive study–test trials, presumably because of the large buildup of interference in that situation. The present study demonstrates that this interference can be overcome through the use of prior knowledge, regardless of whether the prior knowledge plays a direct or only a mediating role and despite the fact that the new information may contradict or be inconsistent with the prior knowledge. In each of the three experiments in this study, a group of participants used their prior knowledge of familiar individuals to mediate the learning of facts about unfamiliar individuals or unfamiliar countries. In each experiment, it was shown that the use of prior knowledge as a mediating device more than doubled the test performance level for this new information. Moreover, in each experiment the MK condition showed less evidence of interference across learning rounds. The results clearly indicate that prior knowledge may effectively be used as a mediator and is consistent with prior research demonstrating the memorial benefits of mediated learning.

It would seem difficult to explain these results in terms of a propositional network account (see, e.g., Anderson, 1983). Although this account has not previously been ap-

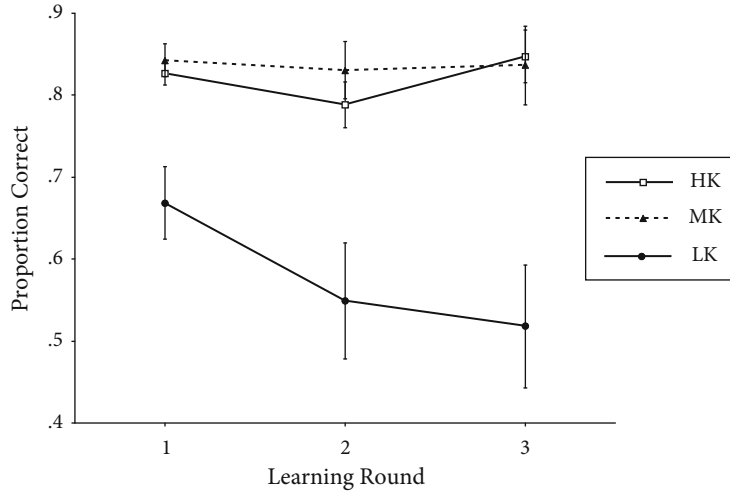

Figure 7. Proportion correct during the learning phase as a function of learning round and knowledge condition in Experiment 3. The country groups were excluded from the analysis. Bars indicate standard errors of the mean. HK, high knowledge; MK, mediated knowledge; LK, low knowledge.

plied to learning but, rather, has been focused on retrieval, it would seem more consistent with the empirical prediction that prior knowledge would interfere with learning new facts, especially when those facts are inconsistent with the prior knowledge (see, e.g., Lewis & Anderson, 1976). On the other hand, these results do seem consistent with the mental model approach, which emphasizes the facilitating effects of integrated representations (see, e.g., Radvansky & Zacks, 1991). Prior knowledge about well-known individuals can be viewed as integrated representations ("person models"; see, e.g., Park, 1986), and the new facts learned can be incorporated within these integrated representations, thereby minimizing interference both from other facts learned about the same individuals and from similar facts learned about other individuals.

The second objective of the study was to directly compare mediated learning to domain-relevant learning. In Experiment 1, this was achieved by comparing two groups of participants, with one group learning facts about familiar individuals and the other group using their prior knowledge of familiar individuals to learn facts about unfamiliar individuals. During the learning and final test phases, there was at least a numerical difference between the HK and MK conditions, with accuracy greater for the HK condition. This finding suggests that mediated learning is not as effective as domain-relevant learning. It was also suggested that the lower performance of the participants in the MK condition was the result of a failure to consistently recall the associated familiar name, in which case prior knowledge could not be used as a mediator. There is evidence supporting this possibility in Experiment 3, which provided more association training and extended the presentation time of the facts. There was no disadvantage for the MK condition relative to the HK condition in that experiment.

Additional purposes of this study were to demonstrate that prior knowledge may be used to mediate the learning of conceptually unrelated information, and also to compare this effect to that obtained when prior knowledge is used to mediate the learning of conceptually similar information. This issue was addressed in Experiment 3, in which the participants used their knowledge of familiar individuals to learn about countries or other individuals. It was found that only during the learning phase, and not during the crucial test phase, was there a greater advantage when the participants used prior knowledge to learn conceptually similar information. In the final test phase, there was a significant advantage for mediated learning even when the subject of prior knowledge was not conceptually similar to the new information.

The present study has practical implications for education. The results of each experiment demonstrate that a simple and fast technique, such as associating information to be learned with preexisting knowledge, can strongly improve learning in situations requiring the acquisition of large amounts of information. Individuals need not be experts within a domain to benefit from their prior knowledge, and the relationship between new and previous knowledge can be arbitrary, with little similarity between the two.

AUTHOR NOTE

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APPENDIX A
Facts Used in Experiment 1, by Name and Fact Category

Names	Verb Phrases	Astrological Signs	Authors	Cars
B. J. Crosby	astrological sign is	Scorpio	Faulkner	Honda
Barbara Fontana	likes books by	Libra	King	Nissan
Brian Burke	drives a	Aries	Steinbeck	Saab
Gina Ferrall	collects	Sagittarius	Poe	Cadillac
Kent Steffes	has a pet	Aquarius	Voltaire	Porsche
Linda Hanley	drinks	Cancer	Hemingway	BMW
Michael Siberry	likes to eat	Taurus	Shakespeare	Toyota
Mike Whitmarsh	likes the month of	Pisces	Dante	Chevy
Nancy Reno	watched the movie	Virgo	Austen	VW
Roberto Lopez	listens to	Leo	Salinger	Ford
Stephanie Bennet	likes to play	Gemini	Koontz	Mercedes
Yvette Freeman	watches the TV show	Capricorn	Grisham	Jeep

Collectibles	Dogs	Drinks	Foods	Months
antiques	spaniel	milk	fish	August
dolls	retriever	tea	burgers	February
pictures	dachshund	juice	bread	September
spoons	bulldog	margaritas	fondue	April
shoes	labrador	Pepsi	American	March
books	collie	Sprite	chicken	June
cars	rottweiler	Coke	Chinese	May
stamps	poodle	beer	pizza	November
cards	mutt	lemonade	vegetables	October
money	dalmation	wine	Mexican	January
coins	huskie	coffee	fruit	July
rocks	shepherd	water	Italian	December

Movies	Music	Sports	TV Shows
Trainspotting	country	softball	CSI
Goodfellas	reggae	soccer	Seinfeld
Contact	rap	hockey	Alias
Poltergeist	hip hop	basketball	ER
Blade	alternative	rugby	Southpark
Scream	oldies	baseball	Friends
Armageddon	classical	volleyball	Oprah
Jaws	ska	pool	Osbournes
Spiderman	techno	football	Cheers
Speed	jazz	golf	Frasier
Terminator	pop	lacrosse	Mash
Titanic	rock	tennis	Simpsons

APPENDIX B
Names of Memory Researchers Used in Experiment 2

Denise Cummins	Marcia Johnson	Rose Zacks
Gordon Logan	Mark McDaniel	Susan Goldman
Jason Hicks	Mary Potter	Tom Nelson
Kim Kash	Robert Proctor	William Estes

APPENDIX C
Facts Used in Experiment 3, by Name, Country, and Fact Category

Person as Topic		Country as Topic	
Name	Verbal Phase	Name	Verbal Phrase
B. J. Crosby	likes to grow	Ghana	major agricultural product is
Barbara Fontana	collects currency in the form of the	Niger	currency is the
Brian Burke	ethnicity is	Nepal	most prevalent ethnic group is
Gina Ferrall	favorite city is	Rwanda	capital city is
Kent Steffes	favorite climate is	Isle of Man	climate is
Linda Hanley	house is worth	Madagascar	population count is
Michael Siberry	speaks	Singapore	citizens speak
Mike Whitmarsh	monthly income is	Malawi	GDP per capita is
Nancy Reno	was born in the	Botswana	is located in the
Roberto Lopez	occupational industry is	Solomon Islands	major industry is
Stephanie Bennet	recently traveled to	Fiji	exports goods to
Yvette Freeman	religion is	Bahrain	principal religion is

Fact Categories

Agricultural Product	Currency Collected/ Official Currency	Ethnicity/ Ethnic Group	Favorite City/ Capital City
cocoa beans	cedi	Akan	Accra
cowpeas	CFA franc	Hausa	Niamey
rice	rupee	Brahman	Kathmandu
coffee	R franc	Hutu	Kigali
vegetables	pound	Manx	Douglas
vanilla	M franc	Merina	Antananarivo
rubber	S dollar	Chinese	Singapore
tobacco	kwacha	Chewa	Lilongwe
livestock	pula	Tswana	Gaborone
coconuts	SI dollar	Melanesian	Honiara
sugarcane	F dollar	Fijian	Suva
fruit	dinar	Bahraini	Manama

Favorite Climate/ Climate Type	House Value/ Population	Language Spoken/ Official Language	Monthly Income/ GDP per Capita
tropical	20 million	English	$2,100
desert	11 million	French	$830
variable	26 million	Nepali	$1,400
temperate	8 million	Kinyarwanda	$1,200
temperate	0.1 million	Manx Gaelic	$21,000
variable	17 million	Malagasy	$760
tropical	5 million	Malay	$24,000
subtropical	12 million	Chichewa	$670
semiarid	2 million	Setswana	$9,500
tropical monsoon	0.5 million	pidgin	$1,700
tropical marine	0.9 million	English	$5,500
arid	0.7 million	Farsi	$14,000

Native Hemisphere/ Hemispheric Location	Occupational Industry/ Major Industry	Recent Travels/ Export Partner	Religion/ Official Religion
northern hemisphere	lumber	The Netherlands	Christianity
northern hemisphere	uranium mining	France	Islam
northern hemisphere	carpet	India	Hinduism
southern hemisphere	cement	Germany	Catholicism
northern hemisphere	financial services	the United Kingdom	Anglicanism
southern hemisphere	meat processing	France	indigenous beliefs
northern hemisphere	electronics	Malaysia	Buddhism
southern hemisphere	tobacco	the United States	Protestantism
southern hemisphere	diamonds	Europe	indigenous beliefs
southern hemisphere	fishing	Japan	Anglicanism
southern hemisphere	tourism	Australia	Christianity
northern hemisphere	petroleum	India	Islam

Note—Names of the fact categories apply to person/countries.

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