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Motivated comprehension regulation: Vigilant versus eager metacognitive control

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The more accurately people assess their comprehension, the more likely they are to engage in study behaviors that precisely target gaps in their learning. However, comprehension regulation involves more than knowing *when* to implement a new study strategy; it also involves deciding *which* strategy will most effectively resolve one's confusion. In two experiments, we explored how people's motivational orientations influence which study strategies they select to regulate their comprehension. In Experiment 1, people who were motivated to vigilantly protect against potential mistakes (i.e., *prevention-focused* individuals) were more likely to adopt a rereading strategy than people who were motivated to eagerly pursue new learning opportunities (i.e., *promotion-focused* individuals). In Experiment 2, this difference in strategy use emerged specifically in response to confusing sentences that had been inserted into the text. Furthermore, by using rereading strategies to resolve their confusion, prevention-focused individuals performed better than promotion-focused individuals on a comprehension test and a transfer task.

"Every path to a new understanding begins in confusion."
—Mason Cooley

The world in which we live can seem overwhelmingly complicated. In the face of such complexity, people often take steps to actively regulate their comprehension of new information. That is, when they experience confusion or a lack of understanding, people actively seek to acquire the information that they need in order to achieve a sufficient level of comprehension.

Such regulation generally reflects a two-step process of monitoring and control (see Nelson & Narens, 1990; cf. Koriat, Ma'ayan, & Nussinson, 2006). *Metacognitive monitoring* refers to those processes that allow people to experience, observe, and reflect on their own mental states (e.g., their comprehension of an unfamiliar or confusing text). The output of monitoring is typically a judgment (e.g., "I don't understand") that can serve as the basis for determining whether comprehension regulation is necessary. *Metacognitive control* refers to the psychological processes involved in selecting and enacting a particular strategy to address the deficits in comprehension that have been identified (e.g., "I will reread the last passage" or "I will keep reading until it makes sense"). Once such control is exerted, this leads to a new set of mental states that are then subject to further monitoring. Thus, the output of metacognitive control serves as the input of metacognitive monitoring and vice versa.

Much of the research on comprehension regulation has focused on how the accuracy of people's metacognitive monitoring affects the efficiency and effectiveness of their metacognitive control (see Dunlosky & Lipko, 2007, for a review). Not surprisingly, the more accurate people are in their assessments of how well (or poorly) they understand something, the more likely they are to engage in study behaviors that precisely target the gaps or deficiencies in their learning (Metcalfe & Finn, 2008; Nelson & Leonesio, 1988). However, successful comprehension regulation depends on more than just accurate monitoring. Even if someone accurately determines that additional action is necessary to achieve a sufficient level of comprehension, he or she must select an effective strategy for pursuing this action. That is, the same metacognitive monitoring process can lead people to adopt different metacognitive control strategies depending on what they feel is the easiest, most appropriate, or simply their preferred method of responding to the feelings of confusion that arise in a given context.

The primary aims of the present article were to investigate whether basic motivations that have been found to influence people's decision making (see Molden & Higgins, 2005) also affect their choice of metacognitive control strategies and whether motivational differences in strategy selection influence the level of comprehension that people ultimately achieve when reading a text. We begin by presenting a more detailed review of the existing research on metacognitive control. We then draw a distinction between people's basic needs for protection and security and their needs for attainment and growth (Higgins, 1997; Molden, Lee, & Higgins, 2008; Molden & Miele, 2008), with special attention to how these fundamental motivations typically affect people's preferences for dif-

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ferent types of judgment and decision-making strategies. Finally, we present two experiments in which we examine whether motivational differences in strategy preference influence comprehension regulation and discuss the potential contribution of our findings to research on metacognition and learning.

Comprehension Regulation and Metacognitive Control

As was previously noted, much of the research on what has been termed *metacomprehension* has been focused on identifying processes that improve the accuracy of metacognitive monitoring, such as summarization (e.g., Thiede & Anderson, 2003), keyword generation (e.g., Thiede, Dunlosky, Griffin, & Wiley, 2005), multiple reading trials (e.g., Dunlosky & Rawson, 2005; Rawson, Dunlosky, & Thiede, 2000), transfer-appropriate processing (e.g., Thomas & McDaniel, 2007; cf. Dunlosky, Rawson, & Middleton, 2005), and self-generated feedback (e.g., Glenberg, Sanocki, Epstein, & Morris, 1987; cf. Maki & Serra, 1992). Although accurate metacognitive monitoring certainly contributes to successful comprehension regulation, this success is contingent on the implementation of effective metacognitive control strategies. That is, even if a student has correctly identified a problem with his or her comprehension, the problem will remain unresolved unless he or she implements an effective control strategy.

In the domain of reading comprehension, there have been two distinct (but complementary) approaches to studying metacognitive control strategies. One approach has been to identify and describe the different types of control strategies that students naturally employ when responding to feelings of confusion. Such strategies include *restating* (i.e., attempting to reduce the material to simpler terms), *rereading* (i.e., looking back to a previous passage), *waiting* (i.e., reading ahead in anticipation of a clarifying statement), and *referencing* (i.e., seeking clarification from an outside source) (see, e.g., Bereiter & Bird, 1985; for a review, see Baker, 1989). The other approach has been to investigate the factors that determine which of these strategies students are most likely to use in a particular context, including the instructions they are given for reading a text (e.g., Baker, 1985), the type of text that they are instructed to read (e.g., Baker & Wagner, 1987; Zabrucky & Commander, 1993), their reading ability (e.g., Garner & Reis, 1981; Zabrucky & Ratner, 1992), their working memory capacity (e.g., Walczyk & Taylor, 1996), and whether they have a learning disability (e.g., Bos & Filip, 1984; O'Neill & Douglas, 1991). Taken together, these two lines of research demonstrate that individual and situational differences in the use of metacognitive control strategies can have important effects on comprehension regulation that are independent of any effects that may result from differences in metacognitive monitoring. For example, O'Neill and Douglas showed that children with ADHD were more likely than normal children to use a skimming strategy and less likely to use a rereading strategy. The authors suggested that this was not because the children with ADHD were unaware of their comprehension difficulties but because the children did not believe that resolving these difficulties was worth the effort required to implement a rereading strategy. They further suggested that, as a result of this difference in strategy preference, the children with ADHD recalled fewer story units from the text than did the normal children.

In this article, we build on the research just reviewed by investigating how differences in people's basic motivations for security and growth influence their selection of metacognitive control strategies and, ultimately, lead to differences in comprehension. The influence of motivation on comprehension regulation in the context of students' achievement goals has been considered in several previous studies. For example, students report being more likely to use deep processing strategies, such as self-testing and rereading, when they have the goal of studying for an exam relative to when they are reading for enjoyment (Lorch, Pugzles Lorch, & Klusewitz, 1993). Similarly, students who pursue their studies with the aim of mastering new skills (a *mastery* goal) report being more likely to use deep processing strategies than students who pursue their studies with the aim of demonstrating their abilities (a *performance* goal) (Ames & Archer, 1988; Nolen, 1988). However, these studies are somewhat limited in that they relied on correlational designs and self-reports to assess people's metacognitive control strategies. Furthermore, although these studies demonstrate that achievement goals can affect people's general motivation to engage in comprehension regulation (i.e., to engage in deep versus shallow processing), they do not explain why two individuals with the same goal (e.g., to perform well on an upcoming exam) may be motivated to employ different types of metacognitive control strategies (e.g., reading an entire textbook chapter multiple times vs. going through the chapter once, but stopping to reread particular passages along the way). Thus, in the present experiments, we directly examined how people's preferences for particular types of control strategies are determined, in part, by their motivations for security and growth.

Motivations for Vigilant Versus Eager Strategies of Goal Pursuit

Previous research demonstrates that the desire to achieve a particular outcome is often accompanied by the motivation to pursue that outcome in a specific manner (Higgins & Molden, 2003; Molden & Higgins, 2005). Although some people are motivated to pursue desired outcomes using *vigilant* strategies, others are motivated to pursue the same outcomes using *eager* strategies (see Molden et al., 2008; Molden & Miele, 2008). Vigilant strategies typically arise from either a temporary or a dispositional motivation to pursue goals that one feels obligated or required to fulfill (Higgins, 1997). Because this *prevention* motivation tends to focus people both on maintaining adequate levels of performance and on protecting against losses that might move them away from their desired end state (e.g., a focus on minimizing incomprehension), it leads them to prefer strategies that involve vigilantly uncovering gaps or inconsistencies in their interpretation of new information. In other words, people who approach their learning goals with a prevention focus prefer to be

cautious when evaluating information, so as to reduce and eliminate the potential for misunderstanding (Molden et al., 2008; Molden & Miele, 2008).

In contrast, eager strategies typically arise from either a temporary or dispositional motivation to pursue goals that one hopes or aspires to fulfill (Higgins, 1997). Because this promotion motivation tends to focus people both on attaining optimal levels of performance and on achieving gains that move them closer to their desired end state (e.g., a focus on maximizing comprehension), it leads them to prefer strategies that involve eagerly searching for new information. In other words, people who approach their learning goals with a promotion focus prefer to be risky when evaluating information, so as not to overlook anything that might allow them to advance their understanding (Molden et al., 2008; Molden & Miele, 2008).

In general, people are motivated to pursue both the goals that they feel obligated to fulfill (i.e., their *oughts*) and the goals that they aspire to achieve (i.e., their *ideals*). However, certain environmental cues can make one type of goal more salient than the other, leading people to temporarily adopt either a prevention or promotion focus and, thus, to temporarily prefer either vigilant or eager strategies for processing new information. For example, because a prevention motivation is experienced as a desire to fulfill one's obligations and to protect against the possibility of loss, environments that frame learning goals in terms of loss-focused incentives (e.g., "If you receive an A in the class, you will *retain* your spot on the debate team") can lead people to prefer vigilant strategies. In contrast, because a promotion motivation is experienced as a desire to achieve one's aspirations and to seek opportunities for gain, environments that frame goals in terms of gain-focused incentives (e.g., "If you receive an A in the class, you will *earn* a spot on the debate team") can lead people to prefer eager strategies (Higgins, 1997; Molden et al., 2008; Molden & Miele, 2008).

In addition to environmental cues that temporarily evoke a prevention or promotion focus, long-term exposure to environments that repeatedly present one type of cue over the other can instill in people a dispositional tendency to interpret their goals as either obligations or aspirations, leading them to consistently prefer either vigilant or eager strategies for processing new information (Higgins et al., 2001; Higgins, Shah, & Friedman, 1997). These dispositional tendencies can be assessed as individual differences using standard questionnaire and reaction-time methods. For example, people's dispositional prevention concerns are typically measured in terms of how much they generally care about fulfilling their responsibilities, duties, and obligations (i.e., their *oughts*), as well as the extent to which these goals are currently on their mind (i.e., readily accessible in memory; see Higgins, 1996). In contrast, people's dispositional promotion concerns are typically measured in terms of how much they generally care about fulfilling their hopes, aspirations, and desires (i.e., their *ideals*), as well as the extent to which these goals are currently accessible. Individuals who report caring more about their oughts than about their ideals, or whose oughts are currently more accessible than their ideals, are considered *prevention focused*; individuals for whom the reverse is true are considered *promotion focused* (Higgins, Idson, Freitas, Spiegel, & Molden, 2003; Higgins et al., 1997; Liberman, Molden, Idson, & Higgins, 2001; Molden & Higgins, 2004, 2008; Shah, Higgins, & Friedman, 1998; see Higgins, 1997).

Irrespective of whether people's prevention or promotion orientations are temporary or dispositional, their preferences for vigilant versus eager judgment strategies have been shown to affect decision making and information processing in a number of important ways. For example, in one study (Crowe & Higgins, 1997; see also Friedman & Förster, 2001; Liberman et al., 2001; Molden & Higgins, 2004, 2008), participants completed a recognition memory task in which they had to identify whether certain words appeared on a previously studied list. Although there were no differences in the participants' overall sensitivity for detecting which words were old and which were new, those with a temporarily induced prevention focus were significantly more biased toward saying that they had not seen a particular word before (producing more correct rejections and misses, which is consistent with a vigilant approach), whereas those with a temporarily induced promotion focus were significantly more biased toward saying that they had seen a particular word before (producing more hits and false alarms, which is consistent with an eager approach; see Tanner & Swets, 1954).

In another study illustrating the differences between prevention- and promotion-focused judgment strategies (Förster, Higgins, & Bianco, 2003), participants were instructed to quickly and accurately proofread as much of a long text as they could within a limited amount of time. The text contained two kinds of errors: surface errors, which were simple typos and misspellings that could be identified without closely reading the text, and contextual errors, which were punctuation mistakes and homonyms that could be identified only by slowing down and taking the meaning of the text into account. As is consistent with a vigilant processing strategy, prevention-focused participants prioritized identifying deeper contextual errors (which reflected a slower and more cautious approach) but ended up not finishing the entire text or missing many of the surface errors. In contrast, as is consistent with an eager processing strategy, promotion-focused participants prioritized finding as many errors as possible (which reflected a faster and riskier approach); but, although they tended to finish more of the text and found more errors overall, they ended up identifying mostly surface errors.

Vigilant Versus Eager Strategies of Comprehension Regulation

In light of these findings, it seems likely that prevention and promotion motivations also have important effects on people's selection of control strategies during comprehension regulation. Consider a case in which a student is reading a text for class. When confusion or uncertainty arises (e.g., as a result of some ambiguity or contradiction in the text), prevention motivations may elicit an attempt to review existing information, so as to eliminate the source of the misunderstanding. That is, if the student

is primarily concerned with protecting against errors in comprehension, he or she may vigilantly adopt what has been described as a *rereading* strategy, which involves revisiting information that has already been processed in order to identify the source of one's confusion. However, in the same context, promotion motivations may elicit an attempt to gather additional information that will help resolve the misunderstanding. That is, if the student is concerned with advancing understanding, he or she should eagerly adopt what has been described as a *waiting* strategy, which involves continuing to process new information in the hopes of achieving further clarity (see Bereiter & Bird, 1985). Thus, the central hypothesis to be tested in the present experiments is as follows: When processing complex or difficult information that is likely to elicit confusion, prevention-focused individuals should regulate their comprehension by reprocessing and reviewing previously encountered information, whereas promotion-focused individuals should be more likely to wait and see whether the new information presented later in the text helps to resolve their confusion.

An additional question that follows directly from this central hypothesis concerns whether a vigilant or eager metacognitive control strategy is more effective when it comes to actually resolving confusion. In general, a vigilant rereading strategy might be more effective than a waiting strategy, because it directly seeks to identify and eliminate the cause of one's confusion. However, when this cause cannot be easily identified or eliminated (e.g., because one does not possess the background knowledge needed to accurately interpret the contents of the text) a waiting strategy should be just as effective (or, rather, ineffective) as a rereading strategy. Thus, we expected prevention-focused individuals to achieve higher levels of comprehension than promotion-focused individuals when they felt confused about inconsistencies or ambiguities that were located entirely within the text (e.g., a contradiction between two statements in the same article), but not when they felt confused about ambiguities that were located partly outside of the text (e.g., complex or technical material that, although logically consistent, goes beyond one's preexisting knowledge).

We performed two experiments to test these predictions. In Experiment 1, we induced participants to temporarily adopt either a prevention or promotion focus and then had them read a complex technical text. Metacognitive control strategies were directly assessed by recording the frequency with which the participants went back to review and reread previous paragraphs as they progressed through the text. The effects of these strategies on comprehension were assessed by having the participants complete a series of multiple-choice questions about the information presented in the text. In Experiment 2, we measured individual differences in participants' dispositional prevention or promotion orientations and then had them read a text that included a particular type of uncertainty: either a *contradiction*, in which a statement was made that directly contradicted an earlier portion of the text, or an *ambiguity*, in which a statement was made that did not contradict an earlier portion of the text, but which still called its meaning into question. As in Experiment 1, metacognitive control strategies were assessed by recording the frequency with which the participants reread the specific sections of the text that gave rise to these contradictions or ambiguities. The effects of such strategies on comprehension were again examined, not only in terms of performance on a multiple-choice test, but also in terms of how successfully information from the text (i.e., knowledge about how to play a novel card game) was transferred to a subsequent procedural task (i.e., one round of the game against a computer opponent).

EXPERIMENT 1

The central objective of Experiment 1 was to demonstrate that people who are primarily motivated by prevention concerns (e.g., protecting against losses in comprehension) tend to select different metacognitive control strategies during comprehension regulation than people who are primarily motivated by promotion concerns (e.g., pursuing gains in comprehension). The participants were informed that they would be completing a reading comprehension task and were given specific incentives designed to evoke either a prevention or a promotion focus. They then read a challenging and complex text that (by assuming background knowledge of the topic that the participants were not likely to possess) had been designed to elicit a moderate level of confusion. The strategies that the participants used to restore comprehension were assessed in terms of how often they chose to review and reread passages of the text. Finally, when the participants were done reading, they answered several multiple-choice questions designed to assess how well they had understood the text. As explained above, because people in a prevention focus prefer vigilant information-processing strategies, we hypothesized that participants in the prevention-focus group would reread more often than those in the promotion-focus group (who should prefer eager information-processing strategies). Furthermore, because substantial background knowledge of the topic was needed in order to fully understand the text, we did not expect the vigilant rereading strategies used by participants in the prevention-focus group to be more effective at increasing comprehension than the waiting strategies used by participants in the promotion-focus group.

Method

Participants

The participants were 88 Northwestern University students (43 men, 45 women; mean age = 18.8 years, $SD = 1.56$) who received course credit for volunteering.

Procedure

The participants were informed that the purpose of the experiment was to learn more about the reading comprehension abilities of college students. They were told that they would begin by reading a text about the risk factors associated with Alzheimer's disease and that they would then answer test questions about this topic based on what they had learned from the text. The instructions also stressed that the participants were free to read the text at their own pace and that (until they continued past the final screen) they could go back to a previous paragraph at any time. Once the participants finished reading the article, they completed a set of six multiple-choice questions

that assessed their comprehension. The questions were presented in a randomized order for each participant.

Activating preferences for vigilant versus eager judgment strategies. After the initial task instructions, all of the participants were informed that their performance on the test questions would determine their entry into a $50 lottery. However, the manner in which this information was framed differed between incentive conditions. In the prevention-incentive condition, the participants were told:

> Although you are already receiving course credit for participating in this experiment, in return for volunteering today, we have also entered you into a lottery with a $50 prize. However, you may lose your entry to the lottery (and lose the chance to win $50) if you do not perform better than the average score for Northwestern students answering the same test questions. If you do perform better than the Northwestern average, you will not lose your entry to the lottery.

This framing was designed to evoke general concerns with maintenance and security and to encourage the use of vigilant judgment strategies. In contrast, in the promotion-incentive condition, the participants were told:

> Although you are already receiving course credit for participating in this experiment, we are also going to give you an opportunity to gain entry into a lottery with a $50 prize. If you perform better than the average score for Northwestern students who have answered the same test questions, you will gain entry in the lottery (and the chance to win $50). If you do not perform better than the Northwestern average, you will not gain entry to the lottery.

In this case, the framing was designed to evoke general concerns with attainment and advancement and to encourage the use of eager judgment strategies. Virtually identical methods have been used to successfully evoke vigilant versus eager strategies in past research (Förster et al., 2003; Maddox, Baldwin, & Markman, 2006; Markman, Baldwin, & Maddox, 2005; Shah et al., 1998). At the end of the experiment, all of the participants were informed that they would be entered into the lottery regardless of their performance on the task.

Assessing comprehension regulation. A brief text (814 words) about the risk factors associated with developing Alzheimer's disease was constructed by synthesizing news articles from several different sources. The text was designed to be conceptually challenging, but grammatically undemanding (Flesch readability score = 34.5 and Flesch–Kincaid grade-level score = 12.0). Alzheimer's disease was selected as the topic to ensure that the participants would view the text as important and worth reading closely and would begin the task with relatively little prior knowledge of the subject matter (thus increasing the challenge posed by the text). The full text is presented in Appendix A.

For the purposes of the reading comprehension task, the text was divided into five paragraphs. These paragraphs were presented one at a time on a computer screen, with the corresponding paragraph number displayed at the top of the screen (e.g., "3 of 5"). At the bottom of the screen, the participants were presented with the option of continuing on to the next paragraph or going back to reread a previous paragraph. As the participants read the text, the computer recorded the amount of time that they spent reading each paragraph, as well as the sequence in which the paragraphs were viewed. These measures were then used to calculate indices of comprehension regulation, including the frequency with which the participants engaged in rereading and the total amount of time that they spent rereading (see below).

Assessing comprehension. Once they finished the reading task, the participants completed six multiple-choice questions that were developed to test their comprehension of the text. Three of the questions concerned information that was explicitly stated in the text and, therefore, could be answered directly from memory. The other three questions concerned information that was not explicitly stated in the text and, therefore, had to be inferred. Sample memory and inference questions are presented in Appendix A.[1]

Results

Two participants did not read past the second paragraph during the reading comprehension exercise, and 11 participants expressed suspicion about the $50 drawing (although it was indeed legitimate). The data from these individuals were eliminated, leaving the responses from 75 participants for analysis.

Coding Rereading

We hypothesized that individuals with a prevention focus would be inclined to use a rereading strategy, which involves vigilantly going back to review previously encountered information in order to identify and eliminate the source of their confusion, whereas individuals with a promotion focus would prefer to use a waiting strategy, which involves continuing to process information in order to clarify their understanding of the text. To test this hypothesis, we coded the participants' behavior during the reading comprehension exercise for evidence of rereading. Any instance in which the participants went back and viewed a previous paragraph for at least 2 sec was coded as a *reread*. This time threshold was set to exclude short or transitional movements between paragraphs that did not constitute the true reprocessing of information. If, after rereading a particular paragraph, the participants went forward again to another paragraph for at least 2 sec and then returned to the first (or any other) paragraph for at least 2 sec, this counted as multiple rereads.

Motivation and Rereading

Preliminary analyses revealed that a small but substantial proportion of the participants (33%) performed at least one reread. However, as was expected, this categorical analysis also showed that the participants in the prevention-incentive condition were approximately twice as likely to have engaged in rereading (45%) as the participants in the promotion-incentive condition (22%) [$\chi^2 = 4.51, p < .05, \Phi = .25$].

Because the average number of rereads per participant is an event count with a positively skewed distribution, statistical analyses of this variable that assume normality may produce misleading results. Thus, we submitted average rereads to a Poisson regression (which is the recommended method for analyzing count data; Gardner, Mulvey, & Shaw, 1995), with incentive condition as the sole predictor (dummy-coded: 0, *prevention*; 1, *promotion*). The results showed a significant effect of incentive condition, such that the participants in the prevention-incentive condition engaged in significantly more rereading ($M = 1.34$) than the participants in the promotion-incentive condition ($M = .57$) ($B = -.86$, Wald = 11.02, $p < .001$).[2]

A continuous analysis of the total time that each participant spent rereading further supported the hypothesis; specifically, the participants in the prevention-incentive condition spent significantly more time rereading ($M = 28.2$ sec) than the participants in the promotion-incentive condition ($M = 7.5$ sec) [$t(73) = 2.53, p < .05, d = 0.59$].

However, an analysis of the average time spent on each instance of rereading (among those who reread at least once) showed that rereads in the prevention-incentive condition ($M = 25.7$ sec) did not differ from those in the promotion-incentive condition ($M = 19.4$ sec) [$t(23) = .66$, $p = .51$, $d = 0.28$]. These results indicate that the observed effects for rereading time are simply a reflection of the greater total frequency of rereading in the prevention-incentive condition.

Motivation and Comprehension

Although the participants in the prevention-incentive condition did engage in rereading more often than the participants in the promotion-incentive condition, we did not predict that this difference in comprehension regulation would actually translate into a difference in comprehension (see above). Given the amount of background knowledge assumed by the text, it was unlikely that the use of a rereading strategy would have substantially improved comprehension. Analyses of the participants' performance on the comprehension questions were consistent with this perspective. A 2 (incentive: prevention vs. promotion) $\times$ 2 (question type: memory vs. inference) mixed ANOVA on the percentage of questions that the participants answered correctly revealed only a main effect of question type.[3] Not surprising, the participants performed better on the relatively easy memory questions (85%) than on the relatively difficult inference questions (58%) [$F(1,72) = 36.57$, $MS_e = 0.072$, $p < .001$, $\eta_p^2 = .34$]. However, the participants in the prevention-incentive condition did not perform any better ($M = 69\%$) than the participants in the promotion-incentive condition ($M = 74\%$) [$F(1,72) = 1.44$, $MS_e = 0.070$, $p = .23$, $\eta_p^2 = .02$]. Furthermore, the main effect of question type was not qualified by a significant incentive $\times$ question type interaction [$F(1,72) = 1.17$, $MS_e = 0.072$, $p = .28$, $\eta_p^2 = .02$]. Thus, presumably because the text assumed background knowledge that the participants did not possess, increases in rereading were not associated with changes in overall comprehension.

Discussion

In support of our central hypothesis, the results of Experiment 1 demonstrate that people's motivational orientations can influence their strategies for comprehension regulation. Specifically, the participants with a temporarily induced prevention focus were more likely than the participants with a temporarily induced promotion focus to implement a rereading strategy while studying a difficult text. This finding provides initial support for our claim that prevention-focused people are motivated to minimize incomprehension by vigilantly addressing the gaps or inconsistencies that limit their understanding of the text, whereas promotion-focused people are more likely to read on and wait for additional information, perhaps in order to maximize their understanding of the text.

Although these results were consistent with our hypotheses, Experiment 1 had several limitations. First, the study did not include a direct measure of the confusion that the participants experienced while reading the text and, thus, did not allow us to determine whether the participants specifically used rereading as a means of responding to this confusion. Second, because the study did not include a manipulation of text difficulty, we were unable to directly examine whether the failure of the prevention-focused participants to outperform the promotion-focused participants on the comprehension test was due to the futility of using a rereading strategy when one does not possess the background knowledge necessary to understand the text. Experiment 2 was designed to address these limitations.

EXPERIMENT 2

In Experiment 2, participants were informed that they would be performing a skill-learning task that involved studying the rules and strategies of a novel card game. They were then asked to read a brief text that included a manipulation of text coherence. By introducing specific sentences that were designed to elicit uncertainty about previous passages in the text, it was possible for us to directly assess the participants' attempts at resolving the confusion caused by these sentences. Because we suspected that everyone (i.e., not just the prevention-focused participants), would be likely to employ a rereading strategy when the manipulated uncertainty was obvious and the resulting sense of confusion was strong, we created two versions of the text. In one version, we included sentences that directly contradicted the information contained in previous passages; in the other version, we included sentences that made the information in the previous passages seem ambiguous (but not contradictory). By using two text conditions, we hoped to establish an important boundary condition for the effects of prevention and promotion motivations. More specifically, we predicted that the prevention-focused participants would be more likely than the promotion-focused participants to use a rereading strategy after encountering a subtle uncertainty in the ambiguous text condition, but not after encountering an obvious uncertainty in the contradictory text condition. Furthermore, because the text used in Experiment 2 did not assume any background knowledge that the participants did not already possess, we expected rereading to serve as an effective means of identifying and eliminating the cause of one's confusion. Thus, we predicted that, in the ambiguous text condition, the prevention-focused participants would achieve higher levels of comprehension than the promotion-focused participants.

In addition to addressing the limitations of Experiment 1, Experiment 2 was designed to extend it in several ways. First, instead of using incentives to induce distinct motivational orientations, we measured individual differences in the participants' prevention and promotion concerns. Second, as well as assessing the participants' actual comprehension of the text using multiple-choice questions, we measured their ability to transfer this newly acquired knowledge to a novel task.

Method

Participants

The participants were 79 Northwestern University students (25 men, 49 women, 5 undetermined; mean age = 18.8 years, $SD = 0.88$) who received course credit for volunteering.

Procedure

The participants were informed that they would be participating in two separate studies: The first study was said to involve a self-description task, whereas the second study consisted of a skill-learning task. After this general introduction, the participants completed a measure of their dispositional motivations for prevention and promotion (i.e., the self-description task; see below). They were then told that they would be learning how to play an obscure card game called German Whist. First, they would read a text that described the rules and strategies for playing German Whist, and then they would be asked to demonstrate what they had learned by playing one round of the game against a computer opponent. As in Experiment 1, the instructions stressed that the participants were free to read the text at their own pace and that, until they continued past the final screen, they could go back and reread previous paragraphs of the text at any time. Once the participants indicated that they had finished reading the text, they were asked to complete 14 multiple-choice questions designed to assess their comprehension (the questions were presented in a randomized order for each participant). Finally, the participants were instructed to play one round of German Whist while the computer recorded a video of all of their moves.

Measuring dispositional preferences for vigilant versus eager judgment strategies. After reading the initial instructions, the participants completed the self-description task, which served as a measure of their dispositional prevention and promotion motivations. Much research has shown that the speed with which people bring particular attitudes to mind (i.e., attitude accessibility) is an indication of how strong these attitudes are and how likely they are to influence behavior (see Bassili, 1996; Fazio, 1995). Similarly, research has also shown that the speed with which people bring to mind their prevention- and promotion-related goals (i.e., goal accessibility) is an indication of how strong these motivations are and how likely they are to drive behavior (Higgins et al., 2003; Higgins et al., 1997; Liberman et al., 2001; Molden & Higgins, 2004, 2008; Shah et al., 1998). Because a prevention focus is experienced as a desire to fulfill one's duties and obligations (i.e., oughts; see Higgins, 1997), the accessibility of these oughts can be used as an index of dispositional prevention strength. In contrast, because a promotion focus is experienced as a desire to fulfill one's hopes and aspirations (i.e., ideals; see Higgins, 1997), the accessibility of these ideals can be used as an index of dispositional promotion strength.

To measure the accessibility of the participants' oughts and ideals in the present study, we first explained to them the difference between these two types of goals. Next, we prompted the participants to list three attributes that they felt they ought to possess, as well as three that they felt it would be ideal to posses. These attributes were solicited in a seemingly random order (one ideal, followed by two oughts, another ideal, another ought, and one final ideal). After typing in each attribute, the participants rated the extent to which they believed that they ought to possess it or the extent to which they would ideally like to possess it on a scale of 1 (*not at all*) to 4 (*very much*). Following each of these ratings, the participants rated the extent to which they believed that they actually possessed the attribute. The overall accessibility of the participants' oughts and ideals was assessed in terms of how quickly they were able to produce the six typed entries and the 12 scale ratings. After performing natural logarithmic transformations to reduce skew (see Ratcliff, 1993), an index of dispositional prevention strength was calculated by averaging the reaction times for the three ought entries, the three ought-extent ratings, and the three ought-actual ratings, whereas an index of dispositional promotion strength was calculated by averaging the reaction times for the three ideal entries, the three ideal-extent ratings, and the three ideal-actual ratings. Because people's individual reaction times to their own oughts and ideals tend to be highly correlated ($r = .61$, $p < .001$, in the present study), these indices are only meaningful when intrapersonal differences in prevention and promotion strength are considered. We therefore computed a single index of motivational focus by subtracting the participants' prevention strength scores from their promotion strength scores. Numerous previous studies have verified the reliability and validity of this measure (see Higgins et al., 2003; Higgins et al., 1997; Liberman, Idson, Camacho, & Higgins, 1999; Liberman et al., 2001; Molden & Higgins, 2004, 2008; Shah & Higgins, 2001; Shah et al., 1998).

Assessing comprehension regulation. The brief text (~1,200 words) that the participants read as part of the skill-learning task described the rules and strategies of an obscure card game called German Whist. The text, which was constructed from documents posted on the Internet, was designed to be conceptually challenging, but grammatically undemanding (Flesch readability score = 76.2; Flesch–Kincaid grade-level score = 7.6). For the purposes of the task, the text was split into two sections. The first section, titled "Rules of German Whist," was divided into seven paragraphs; and the second section, titled "Strategies for German Whist," was divided into five paragraphs. As in Experiment 1, the paragraphs were presented one by one on a computer screen, with the corresponding paragraph number (e.g., "8 of 12") displayed at the top of the screen. At the bottom of the screen, the participants were presented with the option of continuing on to the next paragraph or going back to reread a previous paragraph. As before, the computer recorded the amount of time that the participants spent reading each paragraph, as well as the sequence in which the paragraphs were viewed. The full text is presented in Appendix B.

Manipulating text coherence. Two versions of the German Whist text were created. In the *contradictory* version, Sentence 5 in Paragraph 5 directly contradicted Sentence 3 in Paragraph 2 (rules section), and Sentence 2 in Paragraph 11 directly contradicted the last sentence in Paragraph 8 (strategy section). However, in the *ambiguous* version, Sentence 5 in Paragraph 5 made a vague (but not contradictory) reference to Sentence 3 in Paragraph 2. Similarly, Sentence 2 in Paragraph 11 vaguely referenced the last sentence in Paragraph 8. For example, the relevant sentences in the rules section were:

> Paragraph 2, Sentence 3: "A ruff suit card has the ability to beat any nonruff card that is led in a trick."
>
> Paragraph 5, Sentence 5 (contradictory): "If they are of different suits, the first player automatically loses unless the second player's card is a ruff, in which case the second player loses."
>
> Paragraph 5, Sentence 5 (ambiguous): "If they are of different suits, who wins depends on whether or not the second player's card is a ruff."[4]

Assessing comprehension. The participants completed 14 multiple-choice questions that were developed to test their actual comprehension of the text. Half of these required an understanding of the *ruff suit*, which was the central concept of the first incoherent passage, and were therefore designated as the *target* questions. The remaining 7 questions concerned information discussed elsewhere in the text and were therefore designated as the *filler* questions. Sample target and filler questions are presented in Appendix B.

After completing the comprehension questions, the participants played one round of German Whist against a computer-based opponent.[5] During the game, a separate program captured a screen video of the entire round. These videos were used to construct an index of how well the participants had learned to play the game (see below) and thus served as an additional measure of comprehension. To control for differences in people's experience playing card games, the participants were instructed to answer several questions during the debriefing, including: "Have you ever played any of the following 'trick taking' card games?", "How much experience do you have playing 'trick taking' card games?", and "How much experience do you have playing other kinds of card games?" After computing *z* scores for each of the items, we averaged the scores to create a single index of card game experience ($\alpha = .78$).

Results

Four participants did not read past the second paragraph during the reading comprehension exercise. The data from these participants were eliminated, leaving responses from 75 participants for analysis.

Preliminary analyses that examined general levels of rereading across the entire text (calculated the same way as in Experiment 1) were conducted by submitting the average number of rereads per participant to a hierarchical Poisson regression (see Gardner et al., 1995), in which the main effects of motivational focus and text condition (dummy coded: 0, *contradictory*; 1, *ambiguous*) were assessed in the first step and the motivational focus × text condition interaction was assessed in the second step. In this analysis (and in all that follow), the participants' self-reported card game experience was included as a covariate to control for individual differences in skill level. Replicating those of Experiment 1, the results showed a significant main effect of motivational focus, such that the stronger the participants' prevention focus (and the weaker their promotion focus), the more often they reread passages from earlier in the text ($B = -.80$, Wald = 8.01, $p < .01$). The results also showed a significant main effect of text condition, such that the participants who read the contradictory version of the text reread more often than the participants who read the ambiguous version of the text ($B = -.55$, Wald = 10.56, $p < .01$). The motivational focus × text condition interaction did not reach significance ($B = -.75$, Wald = 2.09, $p = .15$).[6]

Coding Targeted Rereading

An additional prediction was that the participants would specifically use rereading as a means of resolving their confusion about the manipulated uncertainties in the text. To test this prediction, we first created an index of targeted rereading. If, after having read the incoherent passage in Paragraph 5 for the first time, the participants went back and spent at least 2 sec rereading Paragraph 2 (i.e., the paragraph that contained the information most relevant for potentially resolving their confusion), this was coded as a targeted reread. Similarly, if after having read the incoherent passage in Paragraph 11, the participants went back to and spent at least 2 sec rereading Paragraph 8, this was also counted as a targeted reread. Unfortunately, very few participants (5%) displayed targeted rereading at Paragraph 11. We therefore focused our analyses on the targeted rereading that occurred at Paragraph 5.

To confirm that the coherence manipulation in Paragraph 5 did in fact produce targeted (rather than just general) rereading, we performed a categorical analysis of the paragraphs that the participants chose to reread after reading Paragraph 5. Overall, 40% of the participants reread at least one of the first four paragraphs after reading Paragraph 5. More importantly, the results demonstrated that Paragraph 2 was selected by significantly more participants (36%) than was Paragraph 1 (4%; McNemar $\chi^2 = 22.04$, $p < .001$), Paragraph 3 (24%; $\chi^2 = 4.27$, $p < .05$), or Paragraph 4 (8%; $\chi^2 = 17.39$, $p < .001$). These results were confirmed by a significant omnibus test for targeted rereading [Cochran's $Q(3,75) = 44.28$, $p < .001$].

Motivation and Targeted Rereading

Our central hypothesis was that the prevention-focused participants would be more likely to use a targeted rereading strategy than the promotion-focused participants would be, but only when the manipulated uncertainty was relatively weak (i.e., in the ambiguous text condition). To test this hypothesis, we submitted targeted rereading (dummy coded: 0, *did not reread*; 1, *reread*) to a hierarchical logistic regression in which the main effects of motivational focus and text condition (dummy coded: 0, *contradictory*; 1, *ambiguous*) were assessed in the first step, and the motivational focus × text condition interaction was assessed in the second step. The results showed a marginally significant main effect of motivational focus, such that the stronger the participants' prevention focus (and the weaker their promotion focus), the more likely the participants were to use a targeted rereading strategy [Exp(B) = .20, Wald = 3.31, $p = .07$]. However, as was predicted, this main effect was qualified by a significant motivational focus × text condition interaction [Exp(B) = .02, Wald = 4.50, $p < .05$].

As the simple slopes in Figure 1 reveal, the prevention-focused participants were more likely to engage in targeted rereading than the promotion-focused participants in the ambiguous text condition [Exp(B) = .02, Wald = 6.02, $p < .05$], but not in the contradictory text condition [Exp(B) = 1.37, Wald = .07, $p = .80$]. Further simple-slope analyses conducted at 1 *SD* above (for the promotion-focused individuals) and below (for the prevention-focused individuals) the 0 point of the motivational focus index (see Aiken & West, 1991) indicated that the promotion-focused individuals showed a significantly lower probability of targeted rereading in the ambiguous text condition than in the contradictory text condition [Exp(B) = .08, Wald = 5.80, $p < .05$], whereas the prevention-focused individuals did not differ in their rereading between the two text conditions [Exp(B) = .93, Wald = .02, $p = .90$].

Although it appears that the prevention-focused participants preferred the vigilant strategy of reviewing previous information during comprehension regulation, whereas the

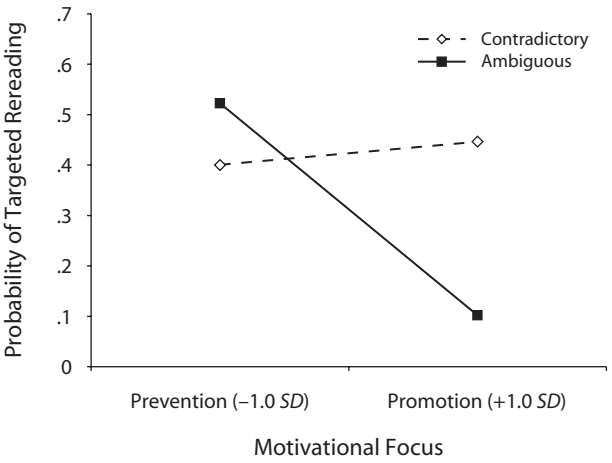

Figure 1. Probability of using a targeted rereading strategy as a function of motivational focus and text condition in Experiment 2.

promotion-focused participants preferred the strategy of continuing to gather new information (except when faced with a blatant contradiction), there is an alternative explanation for these findings that must be considered. It is possible that the prevention-focused participants were more likely to engage in targeted rereading in the ambiguous text condition because they were more sensitive than the promotion-focused participants to the subtle uncertainty that we had inserted into the text. That is, the observed differences in targeted rereading might have resulted from differences in the participants' ability or motivation to detect the ambiguity, as opposed to differences in the strategies that they used to resolve this ambiguity once it had been detected.

To examine this alternative explanation, we analyzed the participants' initial reading times for Paragraph 5. Previous research has shown that people take longer to read sentences that are inconsistent with information presented earlier in a text, presumably because they "engage in some sort of inferential process to attempt to reestablish coherence" (Albrecht & O'Brien, 1993, p. 1067; see also Long & Chong, 2001; Rapp, Gerrig, & Prentice, 2001). Thus, if the prevention-focused participants were more sensitive to the uncertainty manipulation than were the promotion-focused participants, they should have spent more time reading Paragraph 5. A hierarchical regression analysis, in which the main effects of motivational focus and text condition were entered in the first step, followed by the focus × text interaction in the second step, revealed a significant main effect of text condition; unsurprisingly, the participants spent significantly more time processing the blatant inconsistency in Paragraph 5 of the contradictory text condition than they spent processing the subtle uncertainty in Paragraph 5 of the ambiguous text condition [$\beta = -.26$, $t(71) = -2.22$, $p < .05$]. However, contrary to the alternative explanation for the observed differences in targeted rereading, the analysis did not reveal a significant main effect of motivational focus [$\beta = -.08$, $t(71) = -0.68$, $p = .50$] or a significant focus × text interaction [$\beta = -.002$, $t(70) = -0.01$, $p = .99$]. Simple-slope analyses confirmed that motivational focus did not affect Paragraph 5 reading times in the contradictory text condition [$\beta = -.08$, $t(70) = -0.44$, $p = .66$] or in the ambiguous text condition [$\beta = -.08$, $t(70) = -0.52$, $p = .61$].

Because a person's reading time for an entire paragraph is not the most sensitive measure of the confusion generated by a single sentence within that paragraph, we collected data from 31 additional participants (sampled from the same student population as the original participants). After completing the same computer measure of dispositional motivational focus (described above), these participants read the ambiguous version of the German Whist essay one sentence at a time. Analyses of reading times for the critical fifth sentence in Paragraph 5 (i.e., the sentence that introduced the ambiguity) revealed no effects of the participants' motivational focus [$\beta = -.05$, $t(29) = -0.27$, $p = .79$]. Thus, the differences in targeted rereading reported above do not appear to be due to any effects of the participants' prevention or promotion motivations on their ability to detect ambiguity during comprehension.

Motivation and Comprehension

Our initial analyses demonstrated that the prevention-focused participants were more likely to use a targeted rereading strategy than were the promotion-focused participants. Next, we examined how this difference in metacognitive control influenced the participants' performance on the two comprehension measures. As was noted above, we expected that the prevention-focused participants would exhibit higher levels of comprehension than would the promotion-focused participants in the ambiguous text condition, because the prevention-focused participants were more likely to use a targeted rereading strategy to clarify their understanding of the text. However, we did not expect the prevention-focused participants to exhibit higher levels of comprehension in the contradictory text condition, because the promotion-focused participants were just as likely to use a targeted rereading strategy in this case.

Performance on comprehension questions. These hypotheses were initially tested by submitting the percentage of target questions (i.e., those that required an understanding of the key concept in the first manipulated passage) that the participants answered correctly to a hierarchical regression in which the main effects of the participants' motivational focus and a dummy-coded variable representing the text condition (0, *contradictory*; 1, *ambiguous*) were assessed in the first step, followed by the motivational focus × text condition interaction in the second step. The results revealed only a significant motivational focus × text condition interaction [$\beta = -.47$, $t(70) = -2.91$, $p < .01$]. As the simple slopes in Figure 2 reveal, the prevention-focused participants performed significantly better than did the promotion-focused participants on the comprehension questions in the ambiguous text condition [$\beta = -.35$, $t(70) = -2.48$, $p < .05$], but not in the contradictory text condition. Although the figure suggests that the prevention-focused participants actually

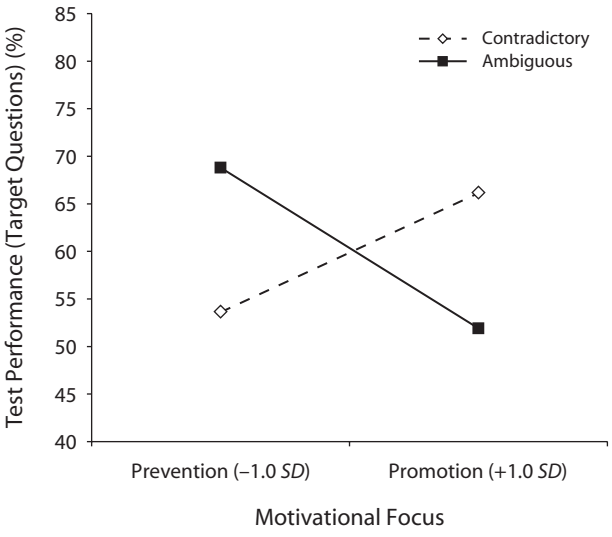

Figure 2. Percentage of target questions answered correctly as a function of motivational focus and text condition in Experiment 2.

Table 1
Coded Game Playing Behaviors in Experiment 2

Behavior	Description	Scale	*M*	*SEM*
	Round 1			
High lead card	The number of times the player led with a card that was higher than the value of the card on top of the fund.	C	2.13	0.28
High winning card	The number of times the player followed the lead card with a card that was higher than necessary to win (i.e., the player possessed a lower winner in her hand).	C	0.38	0.09
High losing card	The number of times the player followed the lead card with a card that was higher than necessary to lose (i.e., the player possessed a lower loser in her hand).	C	0.30	0.08
Bad winning card	The number of times the player followed with a winning card that was higher than the value of the card on top of the fund.	C	0.38	0.10
Give away ruff	The number of times the player made no attempt to win a ruff card that was on top of the fund.	C	2.30	0.19
Follow suit	Whether or not the player started off leading with cards that matched the suit of the top card on the fund.	D	0.34	0.06
Too many tricks	Whether or not the player appeared to use a strategy of winning as many tricks as possible in the first round.	D	0.09	0.04
	Round 2			
High winning card	The number of times the player followed the lead card with a card that was higher than necessary to win.	C	0.30	0.08
High losing card	The number of times the player followed the lead card with a card that was higher than necessary to lose.	C	0.66	0.15

Note—A scale value of "C" indicates a continuous variable, and a scale value of "D" indicates a dichotomous variable.

performed worse than the promotion-focused participants in the contradictory text condition, this association was not significant [$\beta = .26$, $t(70) = 1.63$, $p = .11$].

Additional simple-slope analyses conducted at 1 *SD* above (for the promotion-focused individuals) and below (for the prevention-focused individuals) the 0 point of the motivational focus index (see Aiken & West, 1991) indicated that the promotion-focused individuals showed significantly lower levels of comprehension in the ambiguous text condition than in the contradictory text condition [$\beta = -.44$, $t(70) = -2.39$, $p < .05$], whereas the prevention-focused individuals did not differ in their level of comprehension between the two text conditions [$\beta = .17$, $t(70) = 1.43$, $p = .16$]. Overall, this suggests that the participants who were unlikely to reread (i.e., the promotion-focused participants in the ambiguous text condition) did not understand the text as well as the participants who were likely to reread (i.e., the prevention-focused participants in both conditions and the promotion-focused participants in the contradictory text condition).

Performance during game play. To determine whether differences in comprehension were also exhibited in the participants' game performance, we developed a coding scheme for identifying poor play. Because this was a novel game that the participants had not played before, poor play should have at least partially resulted from a failure to understand the rules and strategies of German Whist. Nine objective indicators of poor play were identified and are presented in Table 1. When interpreting these indicators, it helps to know that each round of German Whist consists of two phases. The first phase involves winning cards in order to assemble the best possible hand, whereas the second phase involves playing the assembled hand in order to earn points. Indicators of poor play were based on the poor decisions that the participants made when assembling their hand in Phase 1, as well as the poor decisions that they made when playing this hand in Phase 2. To analyze the participants' poor play, we coded the screen videos of their game performance for the frequency of each of the nine indicators. We then constructed an overall index of poor play by calculating *z* scores for each indicator and summing these *z* scores for each participant.[7]

This index of poor play was submitted to a hierarchical regression in which the main effects of the participants' motivational focus and a dummy-coded variable representing the text condition (0, *contradictory*; 1, *ambiguous*) were assessed in the first step, followed by the motivational focus × text condition interaction in the second step. The results showed only a marginally significant focus × text condition interaction [$\beta = .36$, $t(51) = 1.76$, $p < .10$]. As the simple slopes in Figure 3 reveal, the prevention-focused participants exhibited significantly less poor play than did the promotion-focused participants in the ambiguous text condition [$\beta = .36$, $t(51) = 2.23$, $p < .05$] but not in the contradictory text condition [$\beta = -.09$, $t(51) = -0.41$, $p = .68$].

Further simple-slope analyses conducted at 1 *SD* above (for the promotion-focused individuals) and 1 *SD* below (for the prevention-focused individuals) the 0 point of the motivational focus difference-score index (see Aiken & West, 1991) indicated that the promotion-focused participants exhibited more bad play in the ambiguous text condition than in the contradictory text condition [$\beta = .53$, $t(51) = 2.38$, $p < .05$], whereas the prevention-focused participants did not differ in their level of bad play across text conditions [$\beta = .09$, $t(51) = 0.64$, $p = .53$]. Thus, in keeping with their performance on the comprehension questions (see above), the participants who were unlikely to reread (i.e., the promotion-focused participants in the ambiguous text condition) were significantly worse at playing the card game than were the participants who were likely to reread (i.e., the prevention-focused participants in both conditions and the promotion-focused participants in the contradictory text condition).

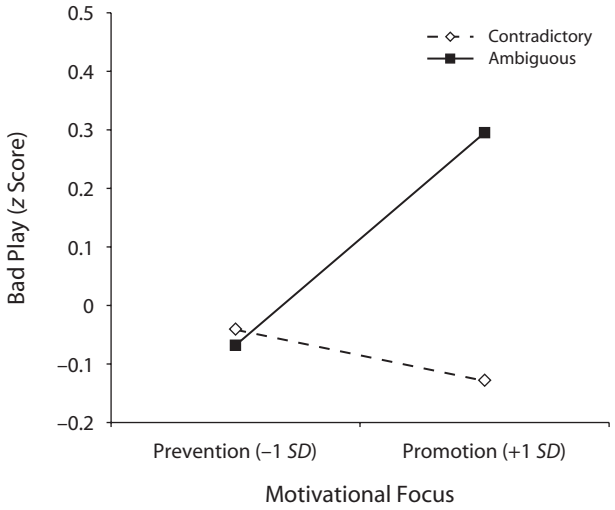

Figure 3. Average number of strategic errors during game play (as a *z* score) as a function of motivational focus and text condition in Experiment 2.

Mediational analyses. As is shown in Figure 4, we constructed a mediational model to test whether targeted rereading accounts for the motivational (i.e., prevention vs. promotion) differences in the participants' comprehension of the text (as measured by their test scores), and whether these differences in turn account for the motivational differences in their task performance (as measured by their game play). Because the influence of motivational focus on task performance was moderated by text condition, such that there was an effect of motivational focus in the ambiguous text condition but not in the contradictory condition, the mediational analyses that follow pertain only to the participants who read the ambiguous version of the text.

We conducted three separate mediational analyses to test our model. First, we showed that the association between motivational focus and test score [$\beta = -.35$, $t(70) = -2.48$, $p < .05$] was no longer significant when targeted rereading was entered into the regression [$\beta = -.25$, $t(69) = -1.75$, $p = .09$], although the association between targeted rereading and test score remained significant [$\beta = .22$, $t(69) = 2.05$, $p < .05$]. The bootstrapping procedure outlined by Preacher, Rucker, and Hayes (2007) revealed this indirect effect to be marginally significant ($Z = -1.65$, $p < .10$).[8]

Second, we showed that the association between targeted rereading and bad play [$\beta = -.42$, $t(51) = -2.92$, $p < .05$] was no longer significant when test score was entered into the regression [$\beta = -.23$, $t(50) = -1.29$, $p = .20$], although the association between test score and bad play remained significant [$\beta = -.39$, $t(50) = -3.12$, $p < .01$]. The same bootstrapping procedure revealed this indirect effect to be significant as well ($Z = -2.01$, $p < .05$).

Finally, we found that the association between motivational focus and bad play [$\beta = .36$, $t(51) = 2.23$, $p < .05$] was no longer significant when both targeted rereading and test score were entered into the regression [$\beta = .09$, $t(49) = 0.59$, $p = .56$], although the association between test score and bad play remained significant [$\beta = -.39$, $t(49) = -2.85$, $p < .01$]. The bootstrapping procedure outlined by Preacher and Hayes (2008) demonstrated that, as was predicted, the total indirect effect of the two mediator variables was significant ($Z = 2.00$, $p < .05$).[9]

Discussion

The results replicated those of Experiment 1: The dispositionally prevention-focused participants were more likely than were the dispositionally promotion-focused participants to implement a metacognitive control strategy that involved reviewing and reprocessing previously encountered information. Moreover, in the present experiment, such reprocessing was found to be both directly triggered by a confusing passage in the text that the participants were reading and directly aimed at resolving this confusion. Overall, these findings suggest that prevention-focused individuals are motivated to minimize incomprehension by vigilantly resolving the inconsistencies that limit their understanding, whereas promotion-focused people appear to be more likely to read on and to wait for additional information, perhaps in order to maximize their understanding of the text.

In addition to replicating this difference in strategy preference, Experiment 2 extends the findings from the previous experiment in at least two ways. First, the results show that prevention- and promotion-focused people are equally likely to employ a rereading strategy when they encounter information that blatantly contradicts what

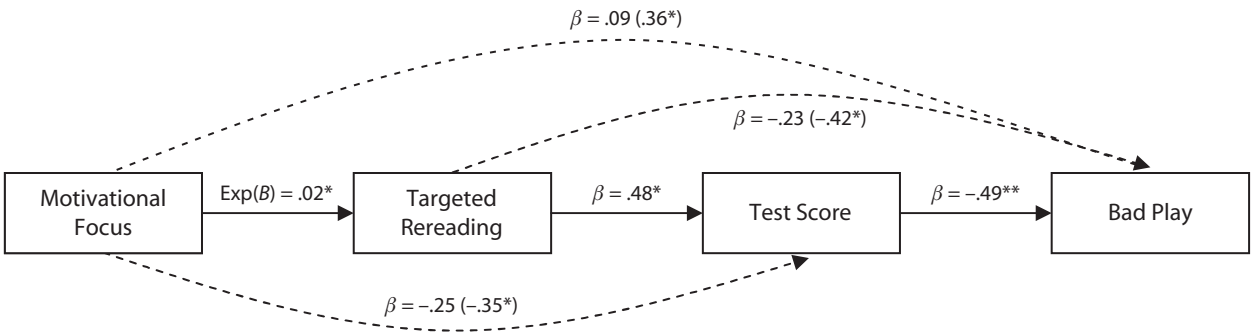

Figure 4. Mediational model of direct and indirect effects of motivational focus on comprehension in the ambiguous text condition of Experiment 2. Values in parentheses indicate the direct effect before the mediator was included in the analysis. $^{*}p < .05$. $^{**}p < .01$.

was previously stated in the text (i.e., in the contradictory text condition). Thus, the experiment establishes an important boundary condition for the effects of prevention and promotion motivations; that is, differences in strategy preference occurred only when the participants encountered information that was mildly confusing but not blatantly contradictory (i.e., in the ambiguous text condition). Second, the study demonstrates that there are circumstances (e.g., when the text does not assume background knowledge that the participants do not possess) in which differences in strategy preference lead prevention-focused individuals to achieve higher levels of comprehension than those achieved by promotion-focused individuals.

GENERAL DISCUSSION

When faced with inconsistent or ambiguous information, people actively strive to overcome their sense of confusion by taking steps to actively regulate their comprehension. In two experiments, we explored how differences in people's general motivational orientations can affect the metacognitive control processes that they employ during comprehension regulation. Overall, the results showed that the participants who were temporarily (Experiment 1) or dispositionally (Experiment 2) focused on their duties and obligations (i.e., in a prevention focus) responded to the confusing passages in a text by vigilantly reprocessing previously encountered information in order to identify and resolve the source of the confusion. In contrast, the participants who were temporarily or dispositionally focused on their hopes and aspirations (i.e., in a promotion focus) responded to the same passages by continuing to process new information in order to achieve further clarity (i.e., by perhaps using a waiting strategy). In addition, these differences in strategy preference were found to emerge directly in response to manipulations of confusion and only when the participants encountered information that was mildly confusing but not contradictory.

Implications for Research on Comprehension Regulation

One notable feature of the present experiments is that, instead of examining the participants' metacognitive control processes by asking them to make explicit judgments about which items (e.g., particular paragraphs from a text or words from a list) they would prefer to study or restudy as part of a subsequent task, as is typically done (e.g., Son & Metcalfe, 2000; Thiede, Anderson, & Therriault, 2003), we adopted a more naturalistic approach of observing the control strategies that the participants spontaneously decided to implement as they were struggling to comprehend a difficult text. Thus, the present results illustrate that comprehension regulation may involve more than just the top-down processes emphasized in previous research. That is, at least in some circumstances, as opposed to checking up on themselves at regular intervals (i.e., periodically asking themselves how well they understand the text), people may wait until a regulatory cue (such as a feeling of confusion) signals that something is wrong and only then consider implementing a control strategy.

Another notable feature of the present experiments is that they illustrate how factors other than monitoring accuracy can affect people's metacognitive control processes. That is, although the accuracy of people's metacomprehension judgments plays an important role in determining whether they will choose to implement a control strategy (see Dunlosky & Lipko, 2007), there may be a number of other factors that people use to determine *which* control strategy will serve as the most efficient means of resolving their confusion.

For instance, although the prevention- and promotion-focused participants in the ambiguous text condition of Experiment 2 were equally likely to detect the ambiguity that we had inserted into the text (as illustrated by their reading times), they used different types of control strategies to resolve their feelings of confusion. Because the prevention-focused participants presumably interpreted this confusion as a threat to their goal of maintaining an acceptable level of understanding, they chose a vigilant rereading strategy that involved directly identifying and addressing the source of the ambiguity. In contrast, because the promotion-focused participants presumably interpreted incomprehension as a missed opportunity to advance toward an ideal level of understanding, they appeared to use a waiting strategy that involved reading ahead for information that might help them to achieve further clarity. Thus, it appears that it is not only the outcome of people's metacomprehension judgments (i.e., their perceived level of comprehension or incomprehension) but what this outcome means to them (e.g., failed efforts at maintenance vs. missed opportunities for advancement) that determines which metacognitive control strategy they are likely to implement.

The present evidence for the effects of motivation on metacognitive control suggests that it may be also possible to reinterpret some past findings in the literature in motivational terms. For example, Zabrucky and Moore (1994, Experiment 1) showed that older adults were less likely than younger adults to selectively reread inconsistent information that had been inserted into a text. That is, the young adults tended only to reread sentences that contradicted other parts of the passage, whereas the older adults were just as likely to reread the consistent sentences as they were to reread the contradictions. Zabrucky and Moore suggested that this difference may have been due to relatively low levels of processing efficiency (see Salthouse & Babcock, 1991) on the part of the older adults. However, an alternative interpretation is that the older adults were more likely than the younger adults to approach the reading task with a prevention focus (perhaps because they were concerned about potential age-related losses in cognitive function) and, thus, were more vigilant about rereading sentences that were only slightly confusing. This motivational explanation may extend to a number of other studies that show general group differences in the use of metacogntive control strategies.

Implications for Learning and Performance

The present experiments demonstrate that motivational differences in strategy selection can, at least in some circumstances, significantly influence the level of comprehension that people achieve when reading a text. More specifically, the vigilant rereading strategy employed by the prevention-focused participants led to better performance on the comprehension questions, as well as to increased transfer of their comprehension to a subsequent task (i.e., better card game performance), but only when their feelings of confusion could be resolved by reviewing previously encountered information (as in Experiment 2). In contrast, this rereading strategy did not lead to better performance when the text assumed background knowledge that the participants did not possess (i.e., when their feelings of confusion could not be resolved by reviewing previously encountered information, as in Experiment 1).

On the whole, then, our findings suggest that one motivational orientation is not uniformly more beneficial for learning and performance than the other. When a learning task requires people to carefully read and to develop a thorough understanding of the material (e.g., reading to prepare for a final exam), and when there are sufficient opportunities to resolve any inconsistencies that may arise, prevention-focused individuals are likely to perform better than promotion-focused individuals. However, when the task requires people to operate under time or resource constraints that preclude careful rereading (e.g., a timed reading comprehension section on a standardized test), or when people attempt to master a new and unfamiliar discipline and do not possess enough background knowledge to benefit from rereading, prevention-focused individuals are unlikely to perform better than promotion-focused individuals. A further examination of the specific circumstances in which one control strategy leads to higher levels of achievement than the other is an important topic for future research (see Molden & Miele, 2008).

Limitations and Future Directions

One limitation of the present experiments is that they provide only indirect evidence for the use of a waiting strategy on the part of promotion-focused participants. That is, we have inferred that the promotion-focused participants were more likely to use a waiting strategy after encountering an ambiguity because they were less likely to use a rereading strategy. However, an alternative explanation for these results is that the promotion-focused participants ignored their feelings of confusion after detecting an ambiguity and continued reading without changing strategies (i.e., without actively waiting for new information that would resolve the ambiguity). Although this explanation cannot entirely be ruled out, it seems unlikely, because the promotion-focused participants took just as long to process an ambiguity as the prevention-focused participants did. This suggests that the promotion-focused participants felt equally confused and were thus equally motivated to resolve the ambiguity in a manner that was consistent with their underlying motivational concerns (i.e., by eagerly seeking out clarifying information). Nevertheless, additional experiments are necessary to confirm that promotion-focused participants do in fact respond to ambiguous information by implementing an eager waiting strategy.

Another limitation of the present experiments is that they relied on a small number of different texts to demonstrate motivational differences in people's use of metacognitive control strategies. Because we cannot be sure that these differences consistently occur during comprehension regulation, a priority for future research should be to demonstrate them in variety of other contexts and with a range of different stimuli.

Concluding Remarks

Although educators continually stress the importance of self-regulated learning (e.g., Boekaerts, 1997), we still know relatively little about how students use their metacognitive judgments to control their study behavior. Whereas past research has focused on how cognitive factors such as memory capacity, reading skill, and judgment accuracy play an important role in determining the kinds of control strategies people use to regulate their comprehension, the present research brings new insight to this problem by examining people's basic motivations for prevention versus promotion. Given the significant impact that such motivations were found to have on comprehension regulation, future researchers should explore additional influences of these and other basic motivations on metacognitive processes.

AUTHOR NOTE

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NOTES

1. As part of a separate experiment that was conducted directly after the present study, participants were provided with information about their progress before they completed the comprehension questions. Some participants were told that they had read an entire article on Alzheimer's disease, whereas the other participants were told that they had only read the first half of the article. This manipulation had no significant simple or interactive effects in any of the analyses reported below and, thus, the results presented collapse across this variable.

2. A *t* test conducted following an inverse transformation of average rereads yielded similar results [$t(73) = 2.14$, $p < .05$, $d = 0.50$].

3. The participants answered one of the inference questions at chance (24.3%). Upon inspection, we determined that the question had been phrased in an ambiguous manner; thus, we excluded this question from all analyses and created an index based on the participants' answers to the two remaining inference questions.

4. The terminology used to describe certain features of the card game was changed so that German Whist would seem less similar to other card games (e.g., contract bridge) than it actually is. For instance, a "ruff" card is really just a "trump" card.

5. The computer version of the game that we used was developed by Meggiesoft and can be downloaded at www.bufton.org/meggiesoft/gerwhist.htm.

6. It should be noted that 56% of the participants performed at least one reread throughout the entire text. This is significantly higher than the rate of rereading observed in Experiment 1 [$\chi^2 = 7.80$, $p < .01$], perhaps because the participants in Experiment 2 had the additional motivation of having to perform the skill that they were reading about in the text.

7. Because of a computer malfunction, we lost the game-playing data for 19 participants. Thus, the following analyses were performed using the data from the remaining 56 participants.

8. This bootstrapping procedure was used because it was specifically designed to test for moderated mediation. Thus, it allowed us to test for mediation within a particular text condition while harnessing the statistical power of the entire sample.

9. An alternate bootstrapping procedure was used because it was specifically designed to estimate the indirect effects of multiple mediators. However, because this procedure does not incorporate moderation, it was applied only to the sample of participants in the ambiguous text condition ($N = 25$).

APPENDIX A

Alzheimer's disease (AD) is now the fourth leading cause of death in adults. It is estimated that 4.5 million Americans and eight million more people worldwide have it. Age is the biggest risk factor for Alzheimer's disease. The number of cases of Alzheimer's disease doubles every five years in people over 65. By age 85, almost half of all people are afflicted. People with AD survive, on average, half as long as similarly aged adults without the disease. With the increasing numbers of aging adults, unless effective methods for prevention and treatment are developed, Alzheimer's disease will reach epidemic proportions, afflicting an estimated 14 million Americans within 50 years.

With respect to Alzheimer's prevention, a large number of risk factors (other than age) have been identified in recent years. Perhaps the most surprising of these pertains to education level. Research suggests that the more years of formal education one has, the less likely one is to develop Alzheimer's. Some experts theorize that longer durations of education may produce denser networks of synapses, the nerve-fiber connections that enable neurons to communicate with one another. This may create a kind of "neural reserve" that helps people to compensate longer for the early brain changes associated with Alzheimer's. Others suggest that the relationship between education level and Alzheimer's can be explained in terms of the correlation between education level and socioeconomic status. They point to evidence that early malnutrition, which is more likely to occur in lower income groups, is associated with smaller brains and with the occurrence of Alzheimer's disease in old age.

The suggestion that malnutrition may lead to Alzheimer's has led to a slew of recent studies linking dietary habits and specific nutritional factors to the risk for Alzheimer's disease or cognitive decline. One study reports that diet rich foods containing vitamin E, such as vegetable oils, nuts, green leafy vegetables, and whole grains, may help protect against Alzheimer's in some people. A protective effect was *not* seen when study participants took vitamin E supplements, as opposed to getting more of the vitamin from foods. Another study found that a low-fat, antioxidant-rich diet was associated with decreased risk of Alzheimer's disease, an association that held up even in people who carry the APOE-4 gene, the only known genetic risk factor for late-onset Alzheimer's. More specifically, the researchers showed that people who ate primarily lean meats (fish and poultry) and fruits and vegetables during midlife had a lower risk of developing Alzheimer's than people who ate a diet higher in fat and sugar and consisting of larger amounts of red and processed meats.

The relationship between fat intake and the occurrence of Alzheimer's suggests that many of the well-established risk factors for cardiovascular disease, including high cholesterol and high blood pressure, may also be risk factors for Alzheimer's disease. A large study by researchers in Finland supports this thinking. Among the study population of 1,449 people, elevated cholesterol and high blood pressure seemed to be strongly linked to the eventual development of Alzheimer's for those carrying APOE-4 gene. More specifically, people who carried the APOE-4 gene were twice as likely to develop Alzheimer's than those with no genetic risk; but if those APOE-4

APPENDIX A (Continued)

carriers also had high blood pressure, they were five times as likely to develop the disease, regardless of whether the people with no genetic risk had high blood pressure themselves. When high cholesterol was also present, the risk jumped to eight times greater than those without APOE-4. This and a number of other studies seem to suggest that what's good for the heart—keeping cholesterol and blood pressure in check—may also be good for the brain. On the other hand, several studies have been conducted that report no relationship between hypertension and Alzheimer's disease.

Another potential set of risk factors for Alzheimer's concerns particular metals found in drinking water, such as aluminum and zinc. Aluminum became a suspect when researchers found its traces in the brains of Alzheimer's patients. Many studies since then have either not been able to confirm this finding or have had questionable results. Aluminum does turn up in higher amounts than normal in some autopsy studies of Alzheimer's patients, but not in all, and the aluminum found in some studies may have come from substances used in the laboratory to study brain tissue. As for zinc, it has been shown that some Alzheimer's patients have low levels of zinc in their brains, especially the hippocampus, which is the part of the brain involved in learning and memory. Other research, however, suggests that too much zinc might be the problem. For example, in one laboratory experiment, zinc caused soluble beta amyloid from cerebrospinal fluid to form clumps similar to the plaques that develop in the brains of Alzheimer's patients. Current experiments with zinc are pursuing this lead in laboratory tests that more closely replicate conditions in the brain.

Sample Memory Question

Which of the following foods is NOT associated with decreased risk of Alzheimer's?

a. Fish

b. Red meat*

c. Nuts

d. Vegetable oil

Sample Inference Question

According to the Finland study, which of the following groups of people are most at risk for developing Alzheimer's?

a. People with hypertension

b. People who carry the APOE-4 gene

c. People with high blood pressure who carry the APOE-4 gene*

d. People with high blood pressure and high cholesterol

APPENDIX B

Rules of German Whist

German Whist is a two-handed version of Whist which was created in England, not Germany. Why it is named German Whist is not known. The deck is the standard fifty-two cards, being the Two through Ace of each suit (i.e., Ace is high). Thirteen cards are dealt to each player. The remaining cards are placed face down by the mat as the FUND (i.e., the pile of cards from which the players can draw).

The top card of the fund is turned face up after the hands have been dealt. The suit of this card defines the RUFF SUIT for the round. A ruff suit card has the ability to beat any nonruff card which is led in a trick. Normally, one must follow the lead suit (i.e., the suit of the card that was led) if possible; otherwise, one may play any card from the other three suits. If the second player follows with a card that is not of the lead or ruff suit, he or she automatically loses the trick.

German Whist is played in two phases. The game starts with the leader (the nondealer at this point) playing a card to the mat; the other player follows. This forms the first TRICK. A trick, then, consists of one card played by each player. During the first phase, the winner of a trick must take the face-up card from the top of the fund and add it to his or her hand. The loser then takes the next card of the fund, which is face-down, without showing it to the winner, so that both players again have 13 cards in their hands. The two cards that were played to the last trick are turned face down and set aside, the top card of the remaining fund is turned face-up, and the winner of the last trick leads a card to the next one.

The purpose of winning tricks in the first phase is to improve your hand as much as possible for the second phase. When all of the cards in the fund have been taken, the second phase is played. In this phase, the winner of each trick earns one point. A round ends after the thirteen tricks of the second phase have been played. The player with the most points wins the round. The first player to win three rounds or accumulate 30 points wins the game.

The winner of a trick is determined by the rank and suit of the cards played. The person who plays first to a trick may play any card, and the other player must play a card of the same suit if possible. Having no cards of the suit led, the second player may play any card. If both cards are of the same suit, the higher card wins the trick. If they are of different suits, [the first player automatically loses unless the second player's card is a ruff, in which

APPENDIX B (Continued)

case the second player loses. / who wins depends on whether or not the second player's card is a ruff.] In German Whist, everything depends on the ruff.

In the computer version of the game, the first round is dealt automatically after you confirm that you will begin. The standard deal is thirteen cards each, dealt singly. The twenty-seventh card of the fund is turned face up (this will go to the winner of the first trick). After the end of each round, the computer will shuffle and deal the cards for the next round.

To play a card on the computer, position the mouse pointer over the card and click the RIGHT mouse button. Alternatively, you may click the LEFT mouse button with the ALT key depressed. Alternatively, you may drag and drop a card directly from your hand to the mat. No action on your part is required to take a card from the fund. The computer will automatically take cards from the fund for each player at the end of each trick. The new card in your hand which was taken from the fund will be shown with a pale green color tint until you move the mouse-pointer across the cards in your hand to play your next card.

Strategies for German Whist

The primary purpose of the first phase is to improve your hand with the intent of winning as many tricks as possible in phase two. A good phase two hand should have a fair number of ruffs and high cards in the other suits. When your hand includes several high cards (more than two) from the same suit, you have what is called a STRONG SUIT. And when your hand includes many cards (more than four, high or low) from the same suit, you have what is called a LONG SUIT. Having a suit that is both strong and long is beneficial, particularly when you have more ruffs than your opponent. Having multiple suits that are strong and long is unnecessary, however, and can even be detrimental when you have a majority of the ruffs.

Improving your hand during the first phase means striving to draw better cards into your hand from the fund than those played, and drawing better cards from the fund than does the opponent. Three considerations are therefore important before deciding either to take the trick or to lead a potential winner that will likely take the trick: (a) whether the top card of the fund is likely to be better or worse than the second unseen fund card, (b) whether the top card of the fund is better or worse than the card you would be playing, and (c) whether the second, unseen card of the fund is likely to be better or worse than the card you would be playing.

For example, if the ruff suit is Hearts and the exposed card is the 5 of Diamonds you would definitely try to lose the trick, as the next card is likely to be better. Even if the exposed card is above average (say the Jack of Spades) you would not use a high card to win it, as all this would achieve would be to replace a high card in your hand by an average one.

When phase two commences, an experienced player good at "remembering the cards" will know exactly which cards the opponent holds. If you are confident that you have more ruffs than your opponent, [and you have at least two strong-long suits, you are in a good position to win the round. / you may be in a good position to win the round depending on how many strong-long suits you have.] Start by leading your ruff cards so that you remove all those of your opponent. Then play a strong-long suit, starting with the high cards and ending with the low cards. Since your opponent will not have any ruff cards left, you should be able to win consecutive tricks without being ruffed back. But remember, the effectiveness of this strategy completely depends on the exact number of strong-long suits you possess.

You should also be wary of a situation where the suits are likely to be evenly sized between you and the opponent, particularly if the opponent may have stronger cards in those suits. In such a case, the opponent may win a series of tricks before you can regain the lead with a higher card or ruff.

Sample Target Question

If the two cards in a trick are from different suits, which card wins?

a. The highest card

b. The lowest card

c. The lead card, if the second card is not a ruff*

d. The lead card, if the second card is a ruff

e. The second card, if the lead card is a ruff

Sample Filler Question

During the first phase, what does a player do after winning a trick?

a. Adds a card to the top of the fund

b. Gives the loser a card

c. Takes a card from the loser and adds it to his or her hand

d. Takes the second card from the top of the fund and adds it to his or her hand

e. Takes the first card from the top of the fund and adds it to his or her hand*

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