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Achievement goals affect metacognitive judgments

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Abstract

The present study examined the effect of achievement goals on metacognitive judgments, such as judgments of learning (JOLs) and metacomprehension judgments, and actual recall performance. We conducted five experiments manipulating the instruction of achievement goals. In each experiment, participants were instructed to adopt mastery-approach goals (i.e., develop their own mental ability through a memory task) or performance-approach goals (i.e., demonstrate their strong memory ability through getting a high score on a memory task). The results of Experiments 1 and 2 showed that JOLs of word pairs in the performance-approach goal condition tended to be higher than those in the mastery-approach goal condition. In contrast, cued recall performance did not differ between the two goal conditions. Experiment 3 also demonstrated that metacomprehension judgments of text passages were higher in the performance-approach goal condition than in the mastery-approach goals condition, whereas test performance did not differ between conditions. These findings suggest that achievement motivation affects metacognitive judgments during learning, even when achievement motivation does not influence actual performance.

Keywords: motivation, achievement goals, metacognition, judgments of learning, metacomprehension judgments

Achievement goals affect metacognitive judgments

Individuals often regulate their cognitive processes to achieve better performance during learning. This self-regulatory mechanism is based on subjective judgments about whether the target material has been sufficiently learned (i.e., metacognitive monitoring), and thus metacognitive monitoring is important for self-regulated learning (e.g., Dunlosky & Thiede, 2004; Metcalfe & Kornell, 2003; Thiede, 1999; Thiede & Dunlosky, 1999). In the field of social and educational psychology, research on achievement motivation suggests that achievement goals are associated with self-regulated learning: achievement goals affect metacognitive activity such as monitoring, subsequently influencing the regulation of learning strategies and outcomes (e.g., Elliot, McGregor, & Gable, 1999; Howell & Watson, 2007; Senko, Hama, & Belmonte, 2013; Vrugt & Oort, 2008). However, if metacognitive monitoring is inaccurate, then any self-regulated learning strategies resulting from achievement goals will be misdirected, and individuals will not learn the material effectively. For example, when students erroneously allocate more study time to well-learned material than to less-learned material, their study might be ineffective, and then their task performance may suffer. Despite the link between achievement goals and metacognitive monitoring, few studies have addressed this relationship; the exceptions (e.g., Kroll & Ford, 1992; Zhou, 2013) have provided only limited evidence of such a relationship. Thus, it is important to reveal how achievement goals affect metacognitive monitoring, as indicated by metacognitive judgments. The present study investigated the effect of achievement goals on metacognitive judgments and actual performance.

Achievement goals

Achievement goals reflect motivation to attain competence in a given context, and have been shown to guide competence-relevant behavior in achievement settings (for reviews, see

Hulleman, Schrager, Bodmann, & Harackiewicz, 2010; Elliot, 2005; Kaplan & Maehr, 2007; Murayama, Elliot, & Friedman, 2012). The traditional dichotomy model of achievement goals distinguishes between mastery-approach goals and performance-approach goals (see Dweck, 1986; Nicholls, 1984). Mastery-approach goals are based on task-based and/or interpersonal competence, and thus this type of goal focuses on the development of one's own competence (e.g., trying to develop one's own mental ability). Performance-approach goals, in contrast, are based on normative competence, and thus this type of goal focus on the demonstration of one's own competence relative to that of other people (e.g., trying to demonstrate greater ability than others; for other models of achievement goals, see Dweck, 1986).

The research on achievement motivation suggests that achievement goals affect learning activities: Mastery-approach goals tend to promote deep-level processes involving the elaboration and integration of information, whereas performance-approach goals tend to promote surface-level processes involving repetitive rehearsal and memorization (e.g., Elliot et al., 1999; Elliot & Moller, 2003; Howell, & Watson, 2007; Ikeda, Castel, & Murayama, 2015; Murayama & Elliot, 2011; Nolen, 1988). Of particular relevance to the present research, mastery-approach goals are positively associated with self-regulated learning, but performance-approach goals are not (e.g., Elliot & Moller, 2003; Ford, Smith, Weissbein, Gully, & Salas, 1998; Middleton, & Midgley, 1997, 2002; Vrugt & Oort, 2008).

Vrugt and Oort (2008), for example, examined the relationship between achievement goals, metacognition, and the use of learning strategies in a classroom setting using questionnaires. They found that the relationship between mastery goals and the usage of learning strategies (i.e., deep cognitive, metacognitive, and resource management strategies) is mediated by metacognitive activity (e.g., metacognitive knowledge, planning, monitoring, and evaluation), and as a result, mastery-approach goals were associated with better performance. In contrast, while performance-approach goals were also positively related to deep cognitive, surface cognitive, metacognitive, and resource management strategies, this link did not mediate metacognitive activity.

Although achievement goals have an important link to self-regulated learning, measures of metacognitive activity used in prior studies reflect only the extent to which participants engaged in these activities; such measures do not, however, provide evidence about the accuracy of the metacognitive judgments themselves. Of course, the extent to which individuals engage in metacognitive activity—such as monitoring--it is important for effective self-regulated learning (e.g., Ford et al., 1998; Pintrich & Groot, 1990; Vrugt & Oort 2008), but the accuracy of metacognitive monitoring is also a key factor (e.g., Dunlosky & Thiede, 2004; Metcalfe & Kornell, 2003; Thiede, 1999; Thiede & Dunlosky, 1999). Therefore, it is important to examine how achievement goals affect not only the extent of metacognitive activities but also the qualitative aspects of these activities, such as metacognitive judgments. Additionally, prior studies reporting the relationship between achievement goals and metacognitive activities were correlational and thus, it is unclear whether achievement goals directly influence metacognitive activities. Thus, the present study focuses more specifically on how achievement motivation affects metacognitive judgments using an experimental manipulation of achievement goals[1]. Given that metacognitive activities in general are affected by achievement goals, there is the possibility that achievement goals also have an influence on metacognitive judgments in particular.

Achievement goals and metacognitive judgments

Metacognitive judgments, according to the cue-utilization framework, are inferential processes using various cues (Koriat, 1997), such as study effort, fluency, and belief (e.g., Begg, Duft, Lalonde, Melnick, & Sanvito, 1989; Benjamin & Bjork, 1996; Castel, McCabe, & Roediger, 2007; Koriat, May'ayan, & Nussinson, 2006; Mueller, Dunlosky, Tauber, & Rhodes, 2014; Rhodes & Castel, 2008). Rhodes and Castel (2008), for example, found that participants predicted words printed in large font to be more recallable than words printed in small font, whereas actual recall performance did not differ between font sizes. This pattern suggests that individuals infer their degree of learning using easily accessible cues (i.e., perceptual fluency) rather than directly accessing the memory traces, regardless of their relevance.

Some research has suggested that motivational factors also influence metacognitive judgments, even if those factors do not directly link to actual performance (e.g., Kassam, Gilbert, Swencionis, & Wilson, 2009; Kroll & Ford, 1992; Lin, Moore, & Zabrucky, 2001; Soderstrom & McCabe, 2011; Zhou, 2013). This motivational effect on metacognitive judgments, for example, was shown in the context of a value-directed remembering paradigm (see Castel, 2008). Soderstrom and McCabe (2011) examined how item value affects judgments of learning (JOLs) using a value-directed remembering task, demonstrating that JOLs for high value items were higher than those for low value items. Importantly, Soderstrom and McCabe's study revealed that this value effect on JOLs was obtained even though the value points were presented after the initial learning. Additionally, Kassam et al. (2009) obtained similar results in terms of monetary rewards. In their experiments, some participants were told that they would obtain rewards for successful recall either before or after the learning of material, whereas other participants did not received the reward instruction. The results demonstrated that the reward instruction elicited higher metacognitive judgments regardless of whether it was provided before or after learning, but the reward instruction only led to higher performance when provided before learning; when provided after learning, it did not lead to higher performance than the no instruction condition. Thus, learners may use cues concerning motivational factors (i.e., point value) in JOL ratings, regardless of their relevance.

Regarding achievement motivation, only a few empirical studies using passages have examined the relationship between achievement goal orientation and metacognitive judgments (Kroll & Ford, 1992; Zhou, 2013). Kroll and Ford (1992) suggested that participants with stronger ego-oriented goals (i.e., performance goals) tend to overestimate their own comprehension compared to participants with stronger task-oriented goals (i.e., mastery goals). According to Kroll and Ford (1992), the desire of self-presentation, such as wanting to “look smart,” is a core component of performance goals (e.g., Elliott & Dweck, 1988; Nicholls, 1984), and as a result, this desire may make individuals believe they will perform at a high level. Additionally, Zhou (2013) assessed participants’ goal orientations using the Achievement Goal Questionnaire (AGQ; see Elliot & McGregor, 2001) and obtained similar results: During a reading task, participants were asked to read several passages and predict their future test performance (i.e., give metacomprehension judgments). Participants then completed a comprehension test. The results of the study demonstrated that participants with a stronger performance-approach goal orientation tended to be overconfident, whereas those with a mastery-approach goal orientation did not have this tendency, suggesting that individuals with performance-approach goals tend to make higher metacomprehension judgments than those with mastery-approach goals (Zhou, 2013). Thus, achievement goals have an effect on metacognitive judgments, but these judgments may not reflect actual performance. In other words, individuals may tend to use the cues related to their achievement goals, regardless of the relevance of those cues to actual performance.

While these studies hint at the relationship between achievement goals and metacognitive judgments, some limitations remain, and research is needed to more directly address important issues. First, there is no direct evidence that achievement goals either bias the metacognitive judgments themselves or directly influence actual performance without influencing metacognitive judgments because previous studies did not compare metacognitive judgments and task performance between different achievement goals. In other words, there is the possibility that the overestimation induced by performance-approach goals in Zhou (2013) resulted not from the enhancement of metacognitive judgments, but rather from decreased task performance. Indeed, when individuals perform difficult tasks, performance-approach goals may decrease task performance (Crouzevialle & Butera, 2013). Given that Kroll and Ford (1992) and Zhou (2013) used relatively difficult materials (i.e., passages), this issue must be resolved. A second limitation of these studies is their correlational design, which severely limits any possible causal inferences, because achievement goals were assessed by a questionnaire in these studies. Therefore, it is unclear whether performance-approach goals directly inflate metacognitive judgments. Only by experimentally inducing different goal states can one obtain more direct evidence regarding how goals can influence learning and metacognition.

The present study

The present study examined how achievement goals affect metacognitive judgments using the experimental manipulation of achievement goals, aiming to provide evidence of the influence of achievement goals on metacognitive judgments. We conducted five experiments using both simple word-pair materials (Experiments 1a, 1b, 2a, & 2b) and more complex materials such as text passages (Experiment 3) to examine the generality of the goal effect on metacognitive judgments. Based on our prediction that performance-approach goals would directly elicit high-level confidence because of the use of non-diagnostic cues concerning achievement goals, as in some prior research (Kroll & Ford, 1992; Zhou, 2013), we expected metacognitive judgments in the performance-approach goal condition to be higher than those in the mastery-approach goal condition, regardless of actual performance. In contrast, a recent meta-analytic review reported that task performance in the mastery-approach goal condition were higher than that in the performance-approach goal condition, but this goal effect was small (see Van Yperen, Blaga, & Postmes, 2015). Therefore, achievement goals might have a small impact on actual performance (but see Murayama & Elliot, 2011). Thus, we would expect that the metacognitive judgments induced by achievement goals do not reflect actual performance. These findings would provide strong evidence that achievement goals can then influence metacognitive judgments.

Experiment 1

In order to directly assess how achievement goals can influence learning and metacognitive judgments, in Experiment 1 we manipulated achievement goals using verbal instructions (see also Elliot & Harackiewicz, 1996; Ikeda et al., 2015; Murayama & Elliot, 2011), prior to participants engaging in the study phase of the experiment. In the mastery-approach goal condition, participants were instructed to develop their own mental ability through a memory task, whereas participants in the performance-approach goal condition were instructed to demonstrate their greater memory ability compared to others. This type of goal instruction has indeed proven to activate the different types of achievement goals (Elliot & Harackiewicz, 1996;

Ikeda et al., 2015; Murayama & Elliot, 2011). In the control condition, participants were not given any specific verbal instruction regarding goals.

For exploratory purposes, we also evaluated how achievement goals influence the effect of goal-unrelated factors, such as encoding fluency, on JOLs to examine the simultaneous use of goal-related and goal-unrelated cues while making JOLs. In the present experiments, encoding fluency was manipulated based on cue-target relatedness as in Castel et al. (2007): a strongly related pair (e.g., *pasture–cow*), a weakly related pair (e.g., *hold–touch*), an unrelated pair (e.g., *foil–trip*), or an identical pair (e.g., *card–card*). The previous studies did not examine this issue, but it is important to reveal whether or not goal-related cues are more predominantly used during metacognitive judgments than goal-unrelated cues for the illustration of the nature of the relationship between achievement goals and metacognitive judgments. Given that Soderstrom & McCabe (2011) demonstrated that the effect of relatedness was not moderated by motivational factors such as point value, individuals might simultaneously use different types of cues. Therefore, we would expect that greater encoding effort would lead to lower JOLs, as in Castel et al. (2007), even when participants were provided with some achievement goals.

Experiment 1a

Method

Participants and Design. Ninety-two participants [age range = 19–76 years; mean age (*SD*) = 34.71 years (11.80)] were recruited through Amazon Mechanical Turk (for the validity of this recruitment procedure, see Buhrmester, Kwang, & Gosling, 2011), but data from six participants were excluded prior to analysis because these participants reported procedural errors. In this and the following studies, we did not conduct any statistical analyses before we finished collecting the data. Participants were paid $2.00 for completing the experiment. Participants were randomly assigned to the control, mastery-approach goals, or performance-approach goals condition.

Materials. The study list consisted of 48 word pairs, but the relatedness between cue and target differed: a strongly related pair (e.g., *pasture–cow*), a weakly related pair (e.g., *hold–touch*), an unrelated pair (e.g., *foil–trip*), or an identical pair (e.g., *card–card*). Twelve pairs of each type were selected from Castel et al. (2007).

Procedure. First, participants were instructed about their achievement goals based on the instructions used by Murayama and Elliot, 2011 (see also Elliot & Harackiewicz, 1996). Participants in the mastery-approach condition were informed that a higher score on the current memory task was associated with the dramatic improvement of mental ability, and they were asked to complete the following memory task with the aim of developing their own mental ability by getting a high score on the memory task. They were also informed that they would be given feedback about their scores. Participants in the performance-approach condition were asked to complete the following memory task with the aim of demonstrating their own strong memory ability compared to others by getting a higher score than other people on the memory task. They were also told that they would be given feedback about their memory test score ranking compared with other people. Participants in the control condition were not given any goals, nor were they informed that they would receive feedback about their scores.

After receiving the instructions, participants performed the memory task, which was identical to the task used in Castel et al. (2007). During the study phase, 48 word pairs were presented one at a time in a random order for 4 seconds each. Immediately after presenting each word pair, participants were given six seconds to make JOL ratings using a scale of 0 (definitely will not remember) to 100 (definitely will remember). After a 3-minute math distractor task, cues (i.e., the first word in each word pair) appeared on the screen one at a time for 8 seconds each, and participants were asked to input the target word that had been paired with that cue.

Results and Discussion

In the following analyses, the alpha level for all statistical tests was set to .05. When we observed main effects of goal and/or pair type, we conducted follow-up multiple comparisons with a Bonferroni correction and the alpha level was adjusted: the alpha level of the goal effect was .0167 and the alpha level of the pair type effect was .0125.

Cued recall performance. We conducted a 3 (achievement goals) × 4 (pair type) ANOVA for correct recall performance (see Table 1). The main effect of goal and the interaction between goals and pair type were not statistically significant, F (2, 83) = 0.19, p = .83, η_G^2 = .00 and F (6, 249) = 0.22, p = .97, η_G^2 = .00,whereas the main effect of pair type was statistically significant, F (3, 249) = 238.33, p < .001, η_G^2 = .51: strongly related pairs > identical pairs > weakly related pairs> unrelated pairs, *t*s > 4.57, *p*s < .001, *d*s > 0.50 (α = .0125).

JOLs. We conducted a 3 (achievement goals) × 4 (pair type) ANOVA for JOL ratings (see Table 1). The interaction between goals and pair type was not statistically significant, F (6, 249) = 0.42, p = .87, η_G^2 = .00, whereas the main effect of pair type was statistically significant, F (3, 249) = 203.34, p < .001, η_G^2 = .44: identical pairs > strongly related pairs > weakly related pairs > unrelated pairs, *t*s > 5.36, *p*s < .001, *d*s > 0.51 (α = .0125). This pattern is consistent with Castel et al. (2007). Importantly, the main effect of achievement goals was marginally statistically significant, F (2, 83) = 2.55, p = .08, η_G^2 = .04. Multiple comparisons using a Bonferroni correction (α = .0167) showed that JOL ratings in the performance-approach goal condition tended to be higher than those in the mastery-approach condition, unlike actual performance, although this effect did not reach statistical significance after Bonferroni correction, *t* (83) = 2.26, *p* = .03, *d* = 0.61. JOLs in the control condition, however, were not different from those in the mastery-approach and performance-approach goal conditions, *t* (83) = -0.98, *p* = .33, *d* = -0.26 and *t* (83) = 1.26, *p* = .21, *d* = 0.35.

Calibration. We conducted a 3 (achievement goals) × 4 (pair type) ANOVA for calibration to examine the effect of achievement goals on calibration (see Table 1). Calibration is the correspondence or difference between metacognitive judgments and actual performance, and negative values indicate underconfidence. The results showed that the interaction between goals and pair type was not statistically significant, *F* (2, 83) = 0.13, *p* = .99, η_G^2 = .00, whereas the main effect of pair type was statistically significant, *F* (6, 249) = 32.51, *p* < .001, η_G^2 = .14: weakly related pairs, identical pairs, and unrelated pairs > strongly related pairs and weakly related pairs > unrelated pairs, *t*s > 3.11, *p*s < .001, *d*s > 0.34 (α = .0125). Additionally, the main effect of achievement goals was marginally statistically significant, *F* (2, 83) = 2.53, *p* = .09, η_G^2 = .03. Multiple comparisons using a Bonferroni correction (α = .0167) showed that JOL ratings in the performance-approach goal condition tended to be higher than those in the mastery-approach condition, unlike actual performance, although this effect did not reach statistical significance after Bonferroni correction, *t* (83) = 2.15, *p* = .03, *d* = 0.58. JOLs in the control condition were not different from those in the mastery-approach and performance-approach goal conditions, *t* (83) = -0.44, *p* = .66, *d* = -0.12 and *t* (83) = 1.68, *p* = .10, *d* = 0.46.

Experiment 1b

Experiment 1a showed that JOLs in the mastery-approach goal condition tended to be lower than those in the performance-approach goal condition, whereas actual recall performance did not differ between conditions. However, the effect of achievement goals on JOLs was not clear because we obtained only marginal effects in Experiment 1a. Additionally, one potential alternative explanation of the goal effect in Experiment 1a is that performance-approach goals induced higher performance pressure (Crouzevialle & Butera, 2013; Senko & Harackiewicz, 2005), which may have led to participants giving JOLs for how well they wanted to recall each pair, rather than how well they thought they actually would recall it. Also, it is possible that the performance-approach goal manipulation motivated participants to demonstrate their competence by giving higher JOL ratings (i.e., they thought higher JOL ratings would indicate better performance). If participants used such heuristics, then JOLs in the performance-approach goal condition in Experiment 1a may have been artificially inflated. In Experiment 1b, we attempted to reduce this possibility and to replicate the main findings from Experiment 1a. Participants were instructed that their predictions should reflect only their predicted memory performance and that their goals (i.e., performance-approach or mastery-approach) related only to memory performance and not to JOLs. Therefore, if the higher JOL ratings in the performance-approach condition did not result from an incorrect heuristic as described above, we would replicate the findings of Experiment 1a.

The only other difference between Experiment 1a and Experiment 1b was the elimination of a no-goal condition in Experiment 1b. Even when individuals are not given explicit achievement goals, they often adopt some on their own (Barron & Harackiewicz, 2001); therefore, there could be no substantial differences in participant behavior, such as JOLs and performance, between the control condition and each goal condition because our “no-goal” condition may have unintentionally included participants with self-induced performance-approach or mastery-approach goals. In fact, Experiment 1a did not indicate significant differences of JOLs and recall performance between the control condition and each goal condition. Also, a recent meta-analytic review reported that task performance in the performance-approach goal condition was comparable to that in the no-goal condition (see Van Yperen et al., 2015). This non-significant differences between participants' goals (and, therefore, behavior) in the control condition and the goal conditions would make it difficult to interpret the present results. Given that our main purpose was the examination of the differences in JOLs and actual performance between the mastery-approach goal condition and the performance-approach goal condition, the comparisons between the control condition and each goal condition are not informative. Therefore, in order to more clearly address our question of how different achievement goals might affect metacognitive judgments and actual performance, we focused on only the mastery-approach goal and performance-approach goal conditions.

Method

Participants and Design. A total of 54 participants [age range = 21–62 years; mean age (*SD*) = 36.54 years (10.51)] were recruited through Amazon Mechanical Turk, but data from one participant was excluded due to a reported procedural error. All participants were paid $2.00 for completing the experiment. Participants were randomly assigned to the mastery-approach goals or performance-approach goals condition.

Materials. As in Experiment 1a, the study list consisted of 48 word pairs selected from Castel et al. (2007), but these pairs were different from those used in Experiment 1a.

Procedure. The procedure was the same as in Experiment 1a, except that participants were instructed that their predictions should reflect only their predicted performance, and their goals were related only to their memory performance and not to their predictions; therefore, they should make JOLs more focused on how well they thought they would recall that pair rather than how well they wanted to recall it or how well they felt they should recall it.

Results and Discussion

As in Experiment 1a, we adopted $\alpha = .05$ in the following analyses. When we observed main effects of pair type, we conducted follow-up multiple comparisons with a Bonferroni correction and an adjusted alpha level (i.e., $\alpha = .0125$).

Cued recall performance. We conducted a 2 (achievement goals) × 4 (pair type) ANOVA for correct recall performance (see Table 2). The results showed that the main effect of goals and the interaction between goals and pair type were not statistically significant, $F\ (1, 51) = 2.34$, $p = .13$, $\eta_G^2 = .03$ and $F\ (3, 153) = 0.70$, $p = .55$, $\eta_G^2 = .005$, whereas the main effect of pair type was statistically significant, $F\ (3, 153) = 112.01$, $p < .001$, $\eta_G^2 = .44$: strongly related pairs and identical pairs > weakly related pairs > unrelated pairs, *t*s > 5.91, *p*s < .001, *d*s > 0.86.

JOLs. We conducted a 2 (achievement goals) × 4 (pair type) ANOVA for JOL ratings (see Table 2). The results showed that the interaction between achievement goals and pair type was not statistically significant, $F\ (3, 153) = 0.48$, $p = .62$, $\eta_G^2 = .003$, whereas the main effect of pair type was statistically significant, $F\ (3, 153) = 195.10$, $p < .001$, $\eta_G^2 = .57$: identical pairs > strongly related pairs > weakly related pairs > unrelated pairs, *t*s > 6.08, *p*s < .001, *d*s > 0.87 ($\alpha = .0125$). Importantly, the main effect of goals was statistically significant, $F\ (1, 51) = 7.14$, $p = .01$, $\eta_G^2 = .08$. JOLs in the performance-approach goal condition were significantly higher than those in the mastery-approach condition, suggesting that enhanced JOLs in the performance-approach goal condition in Experiment 1a was a robust phenomenon. These results are consistent with previous studies of Kroll and Ford (1992) and Zhou (2013).

Calibration. We conducted a 2 (achievement goals) × 4 (pair type) ANOVA for calibration (see Table 2). Neither the main effect of achievement goals nor the interaction between goals and pair type were statistically significant, $F\ (1, 51) = 0.22$, $p = .64$, $\eta_G^2 = .00$ and $F\ (3, 153) = 0.26$, $p = .85$, $\eta_G^2 = .00$, whereas the main effect of pair type was statistically significant, F (3, 153) = 9.67, $p < .001$, $\eta_G^2 = .06$: identical pairs and unrelated pairs > strongly related pairs and weakly related pairs and unrelated pairs > strongly related pairs, *t*s > 3.40, *p*s < .01, *d*s > 0.41 ($\alpha = .0125$).

Experiment 2

Experiments 1a and 1b showed that performance-approach goals led to higher JOLs than mastery-approach goals, but recall performance did not differ between conditions. One possible explanation of our results in Experiments 1a and 1b is that study effort differed between conditions, although we controlled study time. Previous studies examining the relationship between effort and JOLs have shown that longer study time (i.e., higher study effort) evoked lower JOLs (i.e., data-driven effect; e.g., Koriat et al., 2006; see also Koriat & Nussinson, 2009, Experiment 1). This inverse relationship, however, reverses in goal-driven settings. In other words, increasing goal-driven effort, in which individuals intentionally devote the effort to materials according to various goals, leads to higher JOLs because of the use of the heuristic that greater effort is related to better performance (Koriat et al., 2006; Koriat & Nussinson, 2009; Miele & Molden, 2010). Koriat and Nussinson (2009, Experiment 2), for example, examined this relation in a goal-driven situation induced by time pressure. In their mental effort condition, they asked participants to simulate facial tension only while studying items on which they had chosen to spend more time. Their results demonstrated that participants allocated more study time to easy items, and JOLs for easy items in the mental effort condition were higher than JOLs in the control condition, although actual recall performance did not differ between conditions. Given that this mental effort was related to goal-driven regulation, these findings suggest that increasing goal-driven effort might elicit enhanced JOLs in goal-driven settings.

When individuals commit to specific achievement goals for learning, those goals may influence effort (Senko & Harackiewicz, 2005; Senko & Hulleman, 2013): Senko and Harackiewicz (2005), for example, demonstrated that people tend to perceive performance-approach goals as harder to achieve than mastery-approach goals (see also Senko & Hulleman, 2013), and individuals with performance-approach goals tend to experience more performance pressure. As harder goals force individuals to devote greater study effort to achieve their goals (Huberm, 1985), the amount of effort required to attain performance-approach goals may be greater than that required to attain mastery-approach goals. Therefore, performance-approach goals led to extra study effort, and as a result, performance-approach goals might enhance JOLs. Experiment 2 examined this possibility in self-paced study situation.

Experiment 2a

Method

Participants and Design. A total of 81 participants [age range = 21–62 years; mean age (*SD*) = 36.54 years (10.51)] were recruited through Amazon Mechanical Turk, but data from four participants were excluded prior to analysis because of procedural error. All participants were paid $2.00 for completing the experiment. Participants were randomly assigned to the mastery-approach goals or performance-approach goals condition.

Materials. As in Experiments 1a and 1b, the study list consisted of 48 word pairs selected from Castel et al. (2007), but these pairs were different from those used in Experiment 1a and 1b.

Procedure. The procedure was the same as in Experiment 1b, with the exception that participants engaged in self-paced study of the word pairs. First, participants were instructed about their achievement goals, just as in Experiment 1b. Subsequently, word pairs were presented one at a time in a random order; participants memorized these pairs at their own pace and were given six seconds to make JOL ratings. After a 3-minute math distractor task, cues appeared on the screen one at a time for 8 seconds each, and participants completed the word pairs.

Results and Discussion

Cued recall performance. We conducted a 2 (achievement goals) × 4 (pair type) ANOVA for correct recall performance (see Table 3). The results showed that the main effect of goals and the interaction between goals and pair type were not statistically significant, F (1, 75) = 0.21, p = .65, η_G^2 = .002 and F (3, 225) = 1.97, p = .13, η_G^2 = .01, whereas the main effect of pair type was statistically significant, F (3, 225) = 219.90, p < .001, η_G^2 = .53: strongly related pairs and identical pairs > weakly related pairs > unrelated pairs, *t*s > 9.22, *p*s < .001, *d*s > 1.21 (α = .0125).

JOLs. We conducted a 2 (achievement goals) × 4 (pair type) ANOVA for JOL ratings (see Table 3). The results showed that the interaction between achievement goals and pair type was not statistically significant, F (3, 225) = 0.91, p = .41, η_G^2 = .004, whereas the main effect of pair type was statistically significant, F (3, 225) = 198.76, p < .001, η_G^2 = .50: identical pairs > strongly related pairs > weakly related pairs > unrelated pairs, *t*s > 2.41, *p*s < .02, *d*s > 0.27 (α = .0125). Importantly, the main effect of goals was statistically significant, F (1, 75) = 4.07, p = .05, η_G^2 = .03, demonstrating that JOLs in the performance-approach goal condition were significantly higher than those in the mastery-approach condition. The results of Experiments 1a and 1b were replicated in self-paced study situation.

Calibration. We conducted a 2 (achievement goals) × 4 (pair type) ANOVA for calibration (see Table 3). Neither the main effect of achievement goals nor the interaction between goals and pair type were statistically significant, F (1, 75) = 1.38, p = .24, η_G^2 = .01 and F (3, 225) = 0.88, p = .45, η_G^2 = .00, whereas the main effect of pair type was statistically significant, F (3, 225) = 5.47, p < .01, η_G^2 = .03: identical pairs and weakly related pairs > strongly related pairs, ts > 3.47, ps < .001, ds > 0.41 (α = .0125).

Study effort. We also conducted a 2 (achievement goals) × 4 (pair type) ANOVA for study time (see Table 3). The results showed that the interaction between achievement goals and pair type were not statistically significant, F (3, 225) = 0.21, p = .88, η_G^2 = .001, whereas the main effect of pair type was statistically significant, F (3, 225) = 4.86, p = .003, η_G^2 = .01: weakly related and unrelated pair > identical pairs, ts > 2.77, ps < 03, ds > 0.23 (α = .0125). Importantly, the main effect of goals did not reach statistical significance, F (1, 75) = 0.003, p = .96, η_G^2 = .00, suggesting that study time does not affect JOLs. These results suggested that higher JOLs elicited by performance-approach goals did not result from extra study effort.

Experiment 2b

Experiments 1 and 2a consistently found that JOLs in the performance-approach condition were higher than those in the mastery-approach conditions, but actual performance did not differ between conditions. Additionally, this goal effect did not result from extra effort induced by performance-approach goals. However, these experiments were modestly powered because of small sample sizes. Therefore, Experiment 2b was conducted as an exact replication of Experiment 2a with high power. Since this experiment was conducted with high power, Experiment 2b included the control condition, as did Experiment 1a, to re-examine the difference between the control condition and each goal condition. Additionally, it is possible that participants in the mastery-approach goal condition focused on more normative competence (i.e., performance goal) rather than task-based and/or interpersonal competence (i.e., mastery goal) because of ambiguous instructions regarding mastery-approach goals (i.e., “getting a high score on the memory task” and “feedback about memory scores”). Therefore, Experiment 2b included manipulation check questions to evaluate the validity of our manipulation of achievement goals.

Method

Participants and Design. We conducted a power analysis with the effect size of Experiments 1a and power at .95, and as a result, we aimed to collect at least 246 participants. A total of 259 participants [age range = 18–75 years; mean age (*SD*) = 34.11 years (10.84)] were recruited through Amazon Mechanical Turk, but data from 22 participants were excluded prior to analysis because of procedural error. All participants were paid $2.00 for completing the experiment. Participants were randomly assigned to the mastery-approach goals or performance-approach goals condition.

Materials and Procedure. The achievement goal instructions, study list, and procedure were the same as in Experiment 2a, except that this experiment included the control condition. The instructions for the control condition were the same as in Experiment 1a. Additionally, after the memory task, participants completed a questionnaire consisting of two manipulation check questions and nine distractor questions (Ikeda et al., 2015; Murayama & Elliot, 2011). One question was a mastery-approach goal item, which asked participants to rate the extent to which they had tried to develop their own mental abilities by engaging in the memory task. The other manipulation check question was a performance-approach goal item, which asked participants to rate the extent to which they had tried hard to do well compared to other people. These questions were answered on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree).

Results and Discussion

Cued recall performance. We conducted a 2 (achievement goals) × 4 (pair type) ANOVA for correct recall performance (see Table 4). The results showed that the main effect of goals and the interaction between goals and pair type were not statistically significant, *F* (2, 235) = 0.04, *p* = .96, η_G^2 = .0002 and *F* (6, 705) = 1.14, *p* = .34, η_G^2 = .003, whereas the main effect of pair type was statistically significant, *F* (3, 705) = 514.43, *p* < .001, η_G^2 = .43: strongly related pairs and identical pairs > weakly related pairs > unrelated pairs, *t*s > 16.14, *p*s < .001, *d*s > 1.04 (α = .0125).

JOLs. We conducted a contrast analysis for JOLs to examine whether our findings of the goal effect on JOLs would be replicated (see Table 4). Given the results of Experiment 1a, the contrast testing of the goal effect was mastery-approach goal condition = -1, performance-approach goal condition = +1, control condition = 0. Additionally, the contrast of the effect of encoding fluency was strongly related pairs = +1, weakly related pairs = -1, unrelated pairs = -3, identical pairs = +3. We adopted a liner mixed effect model approach including the difference of participants as a random intercept because encoding fluency was a within-subjects variable. The results showed that the interaction between achievement goals and pair type was not statistically significant, *F* (1, 705) = 0.02, *p* = .89, η_G^2 = .0001, whereas the main effect of pair type was statistically significant, *F* (1, 705) = 1119.73, *p* < .001, η_G^2 = .79: identical pairs > strongly related pairs > weakly related pairs > unrelated pairs. Importantly, the main effect of goals was marginally statistically significant, *F* (1, 235) = 2.97, *p* = .08, η_G^2 = .01, demonstrating that JOLs in the performance-approach goal condition tended to be higher than those in the control and the mastery-approach conditions. Additionally, JOLs in the control condition tended to be higher than those in the mastery-approach goal condition. These results are consistent with the findings of previous experiments.

Calibration. We conducted a 3 (achievement goals) × 4 (pair type) ANOVA for calibration (see Table 4). The main effect of achievement goals and the interaction between goals and pair type were not statistically significant, F (2, 235) = 1.15, p = .32, η_G^2 = .01 and F (6, 705) = 1.27, p = .27, η_G^2 = .00, whereas the main effect of pair type was statistically significant, F (3, 705) = 49.62, p < .001, η_G^2 = .07: unrelated pairs, weakly related pairs, and identical pairs > strongly related pairs and unrelated pairs > strongly related pairs, *t*s > 3.41, *p*s < .001, *d*s > 0.25 (α = .0125).

Study effort. We also conducted a 2 (achievement goals) × 4 (pair type) ANOVA for study time (see Table 3). The results showed that the interaction between achievement goals and pair type was not statistically significant, F (6, 705) = 0.44, p = .85, η_G^2 = .001, whereas the main effect of pair type was statistically significant, F (3, 705) = 14.96, p < .001, η_G^2 = .02: weakly related and unrelated pair > strongly related pairs > identical pairs, *t*s > 2.65, *p*s < .01, *d*s > 0.17 (α = .0125). Importantly, the main effect of goals did not reach statistical significance, F (2, 235) = 0.77, p = .46, η_G^2 = .0005, suggesting that study time does not affect JOLs. These results are consistent with Experiment 2a, suggesting that higher JOLs elicited by performance-approach goals did not result from extra study effort.

Manipulation check. We conducted a 3 (achievement goals) × 2 (item type) ANOVA to examine whether our manipulation was successful. Three participants did not complete the manipulation check questionnaire, and thus they were excluded from this analysis. The results showed that the main effects of achievement goals and item type were not statistically significant, F (2, 232) = 1.08, p = .34, η_G^2 = .01 and F (1, 232) = 0.02, p = .89, η_G^2 = .00, whereas the interaction was statistically significant, F (2, 232) = 8.47, p < .001, η_G^2 = .02. In the mastery-approach goal condition, the rating of the mastery-approach goal item (M = 6.28, SD = 1.15, 95% CI [6.02, 6.54]) was significantly higher than that of the performance-approach goal item (*M* = 5.94, *SD* = 1.53, 95% CI [5.59, 6.28]), *t* (79) = 2.66, *p* = .01, *d* = 0.25, 95% CI [0.06, 0.44], suggesting that participants in the mastery-approach goal condition adopted a more intrapersonal standard than interpersonal standard. In the performance-approach goal condition, the rating of the performance-approach goal item (*M* = 5.73, *SD* = 1.47, 95% CI [5.39, 6.06]) was significantly higher than that of the mastery-approach goal item (*M* = 6.22, *SD* = 1.18, 95% CI [5.95, 6.49]), *t* (76) = 3.15, *p* = .002, *d* = 0.37, 95% CI [0.13, 0.61], suggesting that participants in the performance-approach goal condition adopted a more interpersonal standard than intrapersonal standard. In the control condition, the difference between the ratings of mastery-approach goal item (*M* = 5.92, *SD* = 1.37, 95% CI [5.62, 6.23]) and performance-approach goal item (*M* = 5.73, *SD* = 1.50, 95% CI [5.40, 6.07]) did not reach statistical significance, *t* (78) = 1.12, *p* = .27, *d* = 0.13, 95% CI [-0.10, 0.37]. These results indicate that our manipulation of achievement goals was successful.

Experiment 3

Experiments 1 and 2 consistently showed that performance-approach goals elicited higher JOLs than mastery-approach goals, but did not affect actual performance. In Experiment 3, we examined the relationship between achievement goals and metacognitive judgments using complex materials such as passages, similar to Kroll and Ford (1992) and Zhou (2013), attempting to demonstrate the generality of the effect demonstrated in Experiments 1 and 2.

Method

Participants and Design. A total of 79 undergraduate students participated in the experiment, but data from one participant was excluded prior to analysis due to procedural error.

Participants were randomly assigned to the mastery-approach goals or performance-approach goals condition.

Materials. We used six passages used in Thiede, Wiley, and Griffin (2010). Each text consisted of approximately 1000 words, and an average Flesch–Kincard readability score are 11.8. To examine how achievement goals differently influence different levels of representations of the text (i.e., textbase and situation model; see Kintsch, 1998), comprehension tests consisted of three types of multiple-choice questions: unimportant information questions, important information questions, and inference questions, with five questions of each type. Answers to unimportant information questions required recall of information unnecessary for comprehension, whereas answers to important information questions required recall of information necessary for comprehension. These types of questions reflect text memory (i.e., textbase). These questions consisted of the questions developed by Thiede et al. (2010) and us. Furthermore, we used the inference questions developed by Thiede et al. (2010), and this type of question could not be answered based on only memorization of the passage, but rather required inference. This type of question reflects construction of the situation model, which is a deeper level of representation that indicates comprehension (e.g., Thiede et al., 2010).

Procedure. The procedure was similar to that used in prior experiments. First, participants were instructed regarding their achievement goals. After receiving their goal instructions, participants completed the reading task. During this task, six passages were presented in a random order for self-paced study. Before reading each passage, participants were asked to input their own achievement goals, and then the passage was presented. Immediately after reading each passage, participants rated their own comprehension level using a 7-point scale ranging from 1 (*very poorly*) to 7 (*very well*). Finally, participants answered comprehension tests for each text in same order of text presentation.

Results and Discussion

Test performance. We conducted a 2 (achievement goals) × 3 (question type) ANOVA on test scores (see Table 5). The results showed that neither the main effect of goals nor the interaction between goals and question type were statistically significant, F (1, 76) = 0.31, p = .58, η_G^2 = .003 and F (2, 152) = 0.69, p = .51, η_G^2 = .003, whereas the main effect of question type was statistically significant, F (2, 152) = 5.77, p = .004, η_G^2 = .03: inferential questions > important information and unimportant information questions, *t*s > 2.85, *p*s < .02, *d*s > .32 (α after Bonferroni correction was .0167).

Metacomprehension judgments. We conducted a *t*-test on metacomprehension judgments (see Table 5). The results showed that the metacomprehension judgments in the performance-approach goal condition were significantly higher than those in the mastery-approach goal condition, t (76) = 2.01, p = .05, d = 0.46, 95% CI [0.00, 0.90]. This pattern is consistent with the results from our Experiments 1 and 2, indicating that the effect of goal orientation on metacognitive judgments can be generalized to complex text materials.

Reading time. We also conducted a *t*-test to examine whether the reading time in the performance-approach goal condition differed from that in the mastery-approach goal condition (see Table 5). The results showed that reading time did not statistically differ between the two goal conditions, t (76) = 1.06, p = .29, d = 0.24, 95% CI [-0.21, 0.68], suggesting that, similar to our results in Experiments 2a and 2b, higher metacomprehension judgments elicited by performance-approach goals did not result from extra study effort.

General Discussion

The present study examined the causal effect of achievement goals on actual performance and metacognitive judgments, specifically JOLs (Experiments 1a, 1b, and 2) and metacomprehension judgments (Experiment 3) using an experimental manipulation of achievement goals. We predicted that performance-approach goals would lead to higher JOLs than would mastery-approach goals, regardless of actual performance. As expected, in Experiment 1b, JOLs in the performance-approach goal condition were higher than those in the mastery-approach goal condition, regardless of word pair type. Also, in Experiments 2a and 2b, the results were consistent with Experiment 1b in a self-paced study situation. Additionally, Experiment 3 showed that performance-approach goals elicit higher metacomprehension judgments of text passages than did mastery-approach goals, suggesting that achievement goals have a consistent effect on metacognitive judgments across materials of varying complexity. In contrast, actual performance did not differ between goal conditions in our experiments.

To integrate the results from our experiments, in accordance with Cumming (2014), we conducted a meta-analysis of our experiments to estimate the effect sizes of the goal effect on metacognitive judgments and actual performance using Cohen's d and a random-effect model (see Figure 1)[2]. The results of this meta-analysis showed that, according to Cohen (1988), achievement goals have a medium impact on metacognitive judgments, d = 0.44, 95%CI [0.24, 0.63]. In contrast, the goal effect on actual performance was small considering a 95% confidence interval, d = 0.07, 95%CI [-0.12, 0.27].

Achievement goals and cue utilization

In the present study, participants consistently gave higher metacognitive judgments when they received performance-approach goals than when they received mastery-approach goals even though performance did not differ between the two groups. Given this pattern, it seems likely that participants predicted their performance using the cues concerning achievement goals even though these cues did not accurately reflect actual performance. In support of this explanation, Soderstrom and McCabe (2011) also demonstrated that motivational factors affected JOLs even if that motivation (i.e., point value) was presented after the to-be-learned item (see also, Kassam et al., 2009). Their results suggest that regardless of their relevance, motivational factors serve as cues for metacognitive judgments.

In addition to showing the influence of goal-related cues, Experiments 1 and 2 demonstrated that the goal-unrelated cue of encoding fluency (manipulated by word-pair relatedness) also affected JOLs. This result suggests that metacognitive judgments are affected by both goal-related and goal-unrelated cues. If participants had utilized only goal-related cues, we would not have replicated the results of Castel et al. (2007). This was not the case. Importantly, given that the effect of encoding fluency was not moderated by achievement goals, greater goal-unrelated effort seems to have elicited lower JOL ratings even when participants were provided with specific goals. In other words, performance-approach goals might lead to higher metacognitive judgments than mastery-approach goals without diminishing the effect of goal-unrelated cues, such as encoding fluency. This assumption of the simultaneous use of different types of cues is consistent with the results of previous research demonstrating that the effect of relatedness was not moderated by point value (Soderstrom & McCabe, 2011). The current experiments, however, manipulated only word pair relatedness as the goal-unrelated factor, and thus it would be valuable to examine this assumption using other goal-unrelated factors to generalize the current findings.

Although we believe that the results of our experiments provide important evidence of the nature of the relationship between achievement goals and metacognitive awareness, a limitation of the current study is that the precise mechanism of the observed effect is unclear. At least, our results suggest that the higher metacognitive judgments elicited by performance-approach goals do not result from study effort or the complexity of the to-be-learned material. One possible explanation for our results is that a desire for positive self-presentation may bias people's metacognitive judgments (Kroll & Ford, 1992). Our manipulation of performance-approach goals included both an appearance component (i.e., demonstrating competence) and a normative component (i.e., outperforming others), such as self-presentation, based on Hulleman et al. (2010). Given this fact, the desire of self-presentation might drive participants to believe they will perform well in performance-approach goal settings, leading to higher metacognitive judgments in such settings. However, the findings of Zhou (2013) suggests that performance-approach goals not including the desire of self-presentation are also associated with overconfidence. In the study of Zhou (2013), performance-approach goals were measured by AGQ: Performance-approach goal items in the AGQ focus on a normative standard (i.e., outperforming others) rather than self-presentation (e.g., Elliot & McGregor, 2001; Linnenbrink-Garcia, Middleton, Ciani, Easter, O'Keefe, & Zusho, 2012), and self-presentation is one reason for outperforming others (e.g., Gillet, Lafrenière, Vallerand, Huart, & Fouquereau, 2014; Senko, & Tropiano, 2016). Therefore, it is possible that the desire of self-presentation is not a critical factor inflating metacognitive judgments in the performance-approach goal condition.

Another explanation of the current results is that subjective experience of effort is associated with metacognitive judgments. Robinson, Johnson, and Herndon (1997) showed that subjective effort is positively associated with metacognitive judgments rather than study time. Koriat, Nussinson, and Ackerman (2014) obtained similar results: effort ratings were more positively related to JOLs than study time in goal-driven settings. In the achievement goal literature, performance-approach goals are considered more difficult than mastery-approach goals because the success standard of mastery-approach goals is more vague and flexible than performance-approach goals, and thus elicit greater performance pressure (Senko & Harackiewicz, 2005). Additionally, performance-approach goals deplete working memory (Crouzevialle & Butera, 2013). Therefore, although study time did not differ between conditions, participants with performance-approach goals might feel greater subjective effort than those with mastery-approach goals, and as a result, performance-approach goals lead to higher metacognitive judgments. The present study did not examine these possible mechanisms, and thus future research is needed to fully explore the underlying processes of the goal effect on metacognitive judgments.

Achievement goals and metacognitive accuracy

Given that achievement goals affect only metacognitive judgments and not task performance, some achievement goals could lead to inaccurate judgments. To examine the effect of achievement goals on metacognitive accuracy, we conducted a meta-analysis of our experiments to estimate the effect sizes of the goal effect on calibration using Cohen's *d* (i.e., mastey-approach goals vs. performance-approach goals; see Table 6). But, we were not able to calculate calibration in Experiment 3 because we used a 7-point scale for metacomprehension judgments. In the mastery-approach goal condition, participants tended to underestimate their own performance, but the confidence interval of calibration in the mastery-approach goal conditions included 0 (*integrated mean* = -4.46, 95% CI [-9.81, 0.89]). In the performance-approach goal condition, participants did not overestimate future performance (*integrated mean* = 1.35, 95% CI [-3.25, 5.95]), unlike prior studies (Kroll & Ford, 1992; Zhou, 2013). Additionally, the result of our meta-analysis indicated that calibration in the performance-approach goal condition was higher than that in the mastery-approach goal condition, $d = 0.29$, 95% CI [0.07, 0.51], although the effect size is a relatively small. Given that our results are inconsistent with the previous findings (Kroll & Ford, 1992; Zhou, 2013), it is difficult to conclude how achievement goals affect metacognitive accuracy based on the results of the current study. Future research is needed to examine the effect of achievement goals on metacognitive accuracy in more detail.

Avoidance aspect of achievement goals

The present study focused on the effect of approach goals on metacognitive judgments, demonstrating that performance-approach goals elicit higher metacognitive judgments than mastery-approach goals. The research on achievement motivation proposes a 2 × 2 framework of achievement motivation in terms of an approach (i.e., orientation toward achieving competence)–avoidance (i.e., orientation toward avoiding failure) distinction (e.g., Elliot, 2005; Elliot & McGreger, 2001; Elliot, & Thrash, 2001), and prior studies have demonstrated that mastery-avoidance and performance-avoidance goals have different effects on learning strategies and outcomes (e.g., Baranik, Stanley, Bynum, & Lance, 2010; Elliot & McGreger, 2001; Van Yperen, Elliot, & Anseel, 2009; Vrugt & Oort, 2008; Moller & Elliot, 2006). Given this fact, avoidance goals may also have a different effect on metacognitive judgments than the effects observed in the present study. In fact, Zhou (2013) demonstrated that mastery-avoidance goals and performance-avoidance goals elicit overconfidence, similar to performance-approach goals. Therefore, an important next step could be to examine the effect of avoidance goals on metacognitive judgments and accuracy.

Conclusion

In summary, past research suggests that achievement goals affect metacognitive activity, and accurate metacognitive monitoring is important for self-regulated learning. Nevertheless, the fields of cognitive, social, and educational psychology have given less attention to the effects of achievement goal on metacognitive judgments. The present study used an experimental approach to demonstrate a causal relationship between achievement goals and metacognitive judgments: performance-approach goals lead to higher metacognitive judgments than mastery-approach goals, regardless of the complexity of learning material, even when actual performance does not differ. This goal effect on metacognitive judgments did not result from study effort, suggesting that subjective effort and/or belief induced by achievement goals may be responsible for influencing metacognitive judgments. Additionally, the findings suggest that individuals predict their own performance simultaneously using goal-related (i.e., achievement goals) and goal-unrelated cues (i.e., encoding fluency). Although our findings did not reveal the process underlying the goal effect on metacognition, these findings bridge less communicated fields, providing important theoretical and educational suggestions about the relationship between achievement motivation and metacognitive activity. Future research that examines peoples' beliefs regarding how goals influence performance, both for students and for teachers, can shed additional light on how and why people may have specific goals regarding learning and possible interventions.

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Footnotes

1. The standard experimental paradigm of metacognitive judgments asked participants to predict their own performance during the study phase (see Metcalfe & Dunlosky, 2008). Thus, participants do not use spontaneous monitoring in this paradigm, and non-spontaneous use of monitoring might bias the extent of metacognitive activities. For that reason, it is generally difficult to measure both the extent of metacognitive activities and metacognitive judgments in the standard experimental paradigm. Therefore, the present study is complementary to the research examining the relationship between achievement goals and metacognitive activity, such as previous studies (e.g., Vrugt & Oort, 2008).
2. We used the inference questions for our analysis of comprehension in Experiment 3 because comprehension means the construction of a situation model, which is a more complex representation (see Kintsch, 1998). In fact, the research on metacomprehension typically uses inference questions to examine actual comprehension level (e.g., Thiede et al., 2010).

Table 1. *Means, standard deviations, and 95% confidence intervals of correct recall performance, JOLs, and calibration for each pair type in each condition in Experiment 1a.*

		Strongly related		Weakly related		Unrelated		Identical	
		M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Control	Correct recall performance	84.23 (17.47)	[77.45, 91.00]	55.65 (26.55)	[45.36, 65.95]	23.81 (25.22)	[14.03, 33.59]	75.89 (24.88)	[66.24, 85.54]
	JOL	61.32 (20.31)	[53.44, 69.20]	50.39 (20.52)	[42.44, 58.35]	26.89 (15.73)	[20.79, 32.99]	72.35 (23.09)	[63.40, 81.30]
	Calibration	-22.90 (20.73)	[-30.94, -14.87]	-5.26 (22.10)	[-13.84, 3.31]	3.08 (18.94)	[-4.26, 10.43]	-3.54 (25.83)	[-13.56, 6.47]
Mastery-approach goal	Correct recall performance	82.80 (16.09)	[75.79, 88.70]	56.18 (22.97)	[47.76, 64.61]	21.51 (23.65)	[12.83, 30.18]	70.97 (22.03)	[62.89, 70.05]
	JOL	57.55 (20.34)	[50.09, 65.01]	47.60 (19.65)	[40.39, 54.81]	21.93 (15.86)	[16.12, 27.75]	67.06 (23.82)	[58.33, 75.80]
	Calibration	-25.25 (23.22)	[-33.76, -16.73]	-8.58 (24.63)	[-17.62, 0.45]	0.43 (22.22)	[-7.72, 8.58]	-3.90 (26.67)	[-13.68, 5.88]
Performance-approach goal	Correct recall performance	82.41 (16.72)	[75.79, 89.02]	55.56 (25.63)	[45.41, 65.70]	19.14 (24.33)	[9.51, 28.76]	70.68 (28.06)	[59.58, 81.78]
	JOL	67.45 (17.22)	[60.64, 74.26]	58.62 (19.91)	[50.74, 66.50]	28.37 (22.55)	[16.12, 37.29]	78.93 (19.21)	[71.33, 86.54]
	Calibration	-14.95 (26.45)	[-25.42, -4.49]	3.06 (27.92)	[-7.98, 14.11]	9.24 (22.00)	[0.53, 17.94]	8.26 (31.85)	[-4.34, 20.86]

Table 2. *Means, standard deviations, and 95% confidence intervals of correct recall performance, JOLs, and calibration for each pair type in each condition in Experiment 1b.*

		Strongly related		Weakly related		Unrelated		Identical	
		M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Mastery-approach goal	Correct recall performance	76.92 (19.19)	[69.17, 84.68]	57.37 (22.89)	[48.12, 66.62]	25.96 (23.73)	[16.38, 35.55]	75.00 (21.08)	[66.48, 83.52]
	JOL	62.63 (16.40)	[56.01, 69.26]	43.06 (16.50)	[36.40, 49.73]	22.28 (14.81)	[16.30, 28.26]	76.68 (19.48)	[68.81, 84.55]
	Calibration	-14.29 (25.16)	[-19.86, -1.34]	-14.31 (30.62)	[-25.14, -2.88]	-3.68 (23.76)	[-9.01, 5.76]	1.68 (29.28)	[-0.36, 15.06]
Performance-approach goal	Correct recall performance	83.26 (17.57)	[76.30, 90.21]	61.65 (27.29)	[50.85, 72.44]	38.50 (28.36)	[27.30, 49.71]	82.25 (16.41)	[75.76, 88.75]
	JOL	70.37 (16.86)	[63.70, 77.04]	53.64 (17.89)	[46.56, 60.72]	35.48 (19.49)	[27.30, 43.19]	86.56 (17.59)	[79.59, 93.52]
	Calibration	-12.89 (23.60)	[-13.83, 1.57]	-8.01 (27.93)	[-13.78, 8.01]	-3.03 (26.68)	[-4.67, 13.32]	4.30 (21.68)	[-3.59, 14.46]

Table 3. *Means, standard deviations, and 95% confidence intervals of correct recall performance, JOLs, calibration, and study time for each pair type in each condition in Experiment 2a.*

		Strongly related		Weakly related		Unrelated		Identical	
		M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Mastery-approach goal	Correct recall performance	80.70 (17.77)	[74.86, 86.54]	53.51 (22.48)	[46.12, 60.90]	27.63 (24.90)	[19.45, 35.81]	82.67 (16.48)	[77.26, 88.09]
	JOL	69.96 (15.45.)	[64.88, 75.04]	54.68 (18.64)	[48.56, 60.81]	29.25 (19.50)	[22.84, 35.66]	75.66 (21.15)	[68.71, 82.61]
	Calibration	-11.84 (22.32)	[-19.17, -4.50]	-0.14 (28.52)	[-9.52, 9.23]	0.96 (24.52)	[-7.10, 9.02]	-7.24 (26.71)	[-16.01, 1.54]
	Study time	4630 (3721)	[3407, 5853]	4655 (3232)	[3593, 5717]	4750 (2914)	[3792, 5707]	3943 (2783)	[3028, 4857]
Performance-approach goal	Correct recall performance	81.84 (16.54)	[76.48, 87.20]	60.90 (23.27)	[53.36, 68.44]	29.91 (23.47)	[22.31, 37.52]	78.63 (16.64)	[73.24, 84.03]
	JOL	77.89 (13.87)	[73.39, 82.39]	64.82 (17.69)	[59.09, 70.56]	32.66 (25.12)	[24.51, 40.80]	81.31 (15.83)	[76.18, 86.44]
	Calibration	-5.23 (18.79)	[-11.41, 0.95]	2.64 (25.20)	[-5.64, 10.92]	2.31 (27.73)	[-6.80, 11.43]	2.47 (20.49)	[-4.27, 9.20]
	Study time	4498 (2747)	[3607, 5388]	4617 (2741)	[3729, 5506]	4982 (2793)	[4077, 5887]	4007 (2481)	[3203, 4811]

Table 4. *Means, standard deviations, and 95% confidence intervals of correct recall performance, JOLs, calibration, and study time for each pair type in each condition in Experiment 2b.*

		Strongly related		Weakly related		Unrelated		Identical	
		M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Control	Correct recall performance	67.81 (20.95)	[63.15, 72.48]	46.04 (24.84)	[40.51, 51.57]	20.42 (27.71)	[15.02, 25.82]	68.23 (23.98)	[62.89, 73.57]
	JOL	63.25 (19.43)	[58.92, 67.57]	52.29 (19.46)	[47.95, 56.62]	27.71 (17.40)	[23.84, 31.58]	72.63 (24.18)	[67.25, 78.02]
	Calibration	-8.83 (24.53)	[-14.29, -3.37]	4.37 (25.99)	[-1.42, 10.16]	5.94 (27.89)	[-0.27, 12.15]	3.78 (32.24)	[-3.40, 10.96]
	Study time	3990 (3197)	[3278, 4702]	4350 (3559)	[3558, 5142]	4707 (3602)	[3905, 5509]	3432 (2591)	[2855, 4008]
Mastery-approach goal	Correct recall performance	70.52 (21.54)	[65.73, 75.32]	40.21 (24.69)	[34.71, 45.70]	18.75 (22.56)	[13.73, 23.77]	69.69 (25.79)	[63.95, 75.43]
	JOL	61.66 (22.36)	[56.68, 66.64]	50.20 (21.72)	[45.36, 55.03]	30.29 (22.27)	[25.33, 35.24]	71.17 (23.97)	[65.83, 76.50]
	Calibration	-12.51 (24.44)	[-17.95, -7.06]	7.70 (27.26)	[1.63, 13.76]	10.68 (25.57)	[4.91, 16.29]	1.18 (35.28)	[-6.80, 9.15]
	Study time	3690 (2752)	[3078, 4303]	4354 (3374)	[3603, 5105]	4717 (3748)	[3883, 5551]	3598 (2399)	[3064, 4132]
Performance-approach goal	Correct recall performance	69.87 (25.42)	[64.14, 75.60]	42.63 (26.42)	[36.67, 48.58]	18.48 (23.71)	[13.14, 23.83]	69.02 (23.41)	[63.74, 74.30]
	JOL	66.80 (19.46)	[62.41, 71.19]	56.68 (20.04)	[52.16, 61.20]	34.53 (24.00)	[29.12, 39.94]	75.36 (23.36)	[70.09, 80.63]
	Calibration	-6.17 (27.75)	[-12.35, 0.00]	11.81 (29.50)	[5.24, 18.38]	15.08 (27.32)	[9.00, 21.16]	4.42 (28.03)	[-1.82, 10.66]
	Study time	4301 (2807)	[3669, 4934]	5173 (5740)	[3879, 6467]	5046 (3631)	[4228, 5865]	3839 (2334)	[3313, 4365]

Table 5. *Means, standard deviations, and 95% confidence intervals of test performance, metacomprehension judgments, and reading time for each pair type in each condition in Experiment 3.*

		Mastery-approach goal		Performance-approach goal	
		M (*SD*)	95% CI	*M* (*SD*)	95% CI
Test performance	Unimportant information	55.56 (12.89)	[51.37, 59.74]	56.15 (14.14)	[51.57, 60.74]
	Important information	54.19 (9.84)	[50.99, 57.38]	54.62 (10.85)	[51.10, 58.13]
	Inference	59.66 (14.42)	[54.98, 64.34]	60.00 (10.61)	[56.56, 63.44]
Metacomprehension judgments		5.00 (0.98)	[4.68, 5.32]	5.43 (0.89)	[5.14, 5.72]
Reading time		22.62 (8.90)	[19.73, 25.51]	20.65 (7.54)	[18.20, 23.09]

Table 6. *Means, standard deviations, and 95% confidence intervals of calibration in Experiments1a, 1b, 2a, 2b, and the integrated results. A negative calibration value represents underestimation of memory performance.*

	Mastery-approach goals		Performance-approach goals		Control	
	M (*SD*)	95% CI				
Experiment 1a	-9.33 (19.37)	[-16.43, -2.22]	1.40 (20.78)	[-6.82, -9.62]	-7.16 (16.38)	[-13.51, -0.81]
Experiment 1b	-7.65 (22.34)	[-16.68, 1.38]	-4.91 (20.17)	[-12.89, 3.07]	-	-
Experiment 2a	-4.56 (20.17)	[-11.19, 2.07]	0.55 (18.02)	[-5.29, 6.39]	-	-
Experiment 2b	1.74 (23.06)	[-3.39, 6.87]	6.28 (22.68)	[1.17, 11.40]	1.31 (22.68)	[-3.73, 6.36]
Integrated results	-4.46 (21.51)	[-9.81, 0.89]	1.35 (20.66)	[-3.25, 5.95]	-2.74 (20.45)	[-11.03, 5.56]

Figure 1. *Meta-analysis of the five present experiments on metacognitive judgments and actual performance: left panel represents Cohen's d of metacognitive judgments, and right panel represents Cohen's d of actual performance . Error bars represent 95% confidence intervals.*