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The Influence of Judgments of Learning on Long-Term Learning and Short-Term Performance

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Students must retain information they learn in class over the long term because it may be foundational for upper-level classes or for use in their field. Recently, researchers have demonstrated that making judgments of learning (JOLs) can enhance students' short-term performance; however, it is unclear how they influence long-term learning. We evaluated this issue in three experiments. Participants studied related word pairs (e.g., castle–king). Half of the participants made a JOL for each pair and half did not. Participants took a cued-recall test after either a long retention interval (2 days) or short retention interval (3 min). Participants who made JOLs outperformed participants who did not, which was evident on long-term learning as well as short-term performance. Continuously cumulating meta-analyses revealed that these effects were strong (long-term learning, $d = .66$; short-term performance, $d = .71$). Thus, making JOLs appears to be an effective strategy to increase long-term retention of related information.

General Audience Summary

Understanding what you do and do not know (i.e., monitoring your learning) is essential for effectively regulating study. One way this is investigated is by having people make predictions about the likelihood that they will remember a given item (i.e., judgments of learning, JOLs). Recently, researchers have found that people who make JOLs when studying related word pairs (e.g., castle–king) remember significantly more of them compared to people who do not make JOLs when tested after 3 min. Importantly, it is unclear whether the benefit will maintain over a longer delay to impact long-term learning. In three experiments we investigated whether JOLs enhance long-term learning. To do so, participants studied related word pairs. Half of the participants made a JOL for each word pair and half did not. Additionally, half of the participants took a cued-recall test (e.g., castle– ?) 3 min after study and half of the participants took the test 2 days after study. In all of the experiments, participants who made JOLs recalled more word pairs than participants who did not. Most important, this finding was observed following both the 2-day and 3-min retention interval, and a continuously cumulating meta-analysis revealed these effects to be strong. Thus, making JOLs appears to be an effective way to improve long-term learning of related information.

Keywords: Long-term learning, Short-term performance, Judgments of learning, Reactivity, Metamemory

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A primary goal of educators is to promote durable learning that maintains over time. Retention over lengthy intervals is critical because knowledge gained in introductory-level classes is foundational for upper-level classes and for later careers. Thus, it is important to identify and evaluate factors that enhance students' long-term learning (for reviews see Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Roediger & Pyc, 2012). Recently, researchers have found that making judgments of learning (JOLs) for related information can enhance short-term test performance (e.g., Soderstrom, Clark, Halamish, & Bjork, 2015). As such, it is possible that they will likewise enhance long-term learning; however, it is also possible that they will differentially influence short-term performance and long-term learning (cf. the distributed practice effect; for a review see Carpenter, Cepeda, Rohrer, Kang, & Pashler, 2012). The primary goal of the present research was to investigate how JOLs influence long-term learning relative to short-term performance. Further, because research on the direct influence of JOLs on short-term performance is new, a secondary goal was to estimate a pooled effect size separately for short-term performance and long-term learning using a continuously cumulating meta-analysis (CCMA; Braver, Thoemmes, & Rosenthal, 2014). We begin by distinguishing between short-term performance and long-term learning, followed by a review of the literature on the direct effects of JOLs on short-term performance.

Soderstrom and Bjork (2015) define *learning* as "the relatively permanent changes in behavior or knowledge that support long-term retention and transfer", whereas *performance* is defined as "the temporary fluctuations in behavior or knowledge that can be observed and measured during or immediately after the acquisition process" (p. 176). Distinguishing between short-term performance and long-term learning is important because factors that influence short-term performance may be somewhat transient and may not impact long-term learning or may impact it differently (for reviews see Soderstrom & Bjork, 2013, 2015). For instance, consider seminal research by Bahrick (1979). Participants studied English–Spanish translations over a series of six sessions. Importantly, some participants had massed study sessions whereas other participants had spaced study sessions. Participants began each session with a cued-recall test after which they restudied the translations. For all participants, a final cued-recall test was taken 30 days after the final study session. Short-term performance (i.e., cued-recall performance during the study sessions) was enhanced by short retention intervals during study (i.e., massed study) whereas long-term learning (i.e., cued-recall performance on the final test) was enhanced by long retention intervals during study (i.e., spaced study). In other words, long-term learning and short-term performance were dissociable.

Similarly, JOLs may have a unique reactive effect on long-term learning relative to short-term performance. JOL reactivity refers to incidences in which test performance significantly differs between JOL and no-JOL conditions or groups (either positively or negatively), whereas no JOL reactivity refers to incidences in which test performance does not differ between JOL and no-JOL conditions. Recently, Soderstrom et al. (2015) demonstrated positive JOL reactivity on short-term test performance. Participants studied a list of related word pairs (e.g., loaf–bread) and unrelated word pairs (e.g., sack–flag). Each word pair was presented for 8 s. Participants in the JOL group were prompted to make their JOL after 4 s of the presentation time had elapsed, and used the remaining 4 s to make their judgment. Participants in the no-JOL group did not make JOLs. Following study, participants completed a 3-min distractor task, which was followed by a cued-recall test (e.g., loaf– ?). For related pairs, test performance for the JOL group was elevated relative no-JOL group, whereas for unrelated pairs test performance in the two groups was equivalent.

Positive reactivity on short-term performance has also been observed in other experiments (e.g., Arbuckle & Cuddy, 1969; Begg, Duft, Lalonde, Melnick, & Sanvito, 1989; Dougherty, Scheck, Nelson, & Narens, 2005; Yang et al., 2015; Zechmeister & Shaughnessy, 1980). However, the goal of these studies was not to evaluate JOL reactivity, and thus some methodological concerns should be taken into account when interpreting their outcomes (e.g., study time was not equated between the JOL and no-JOL groups). Positive reactivity may occur because, according to Soderstrom et al. (2015), the act of generating JOLs strengthens the associative relationship between the cue and target for related word pairs, leading to enhanced recall for participants who made JOLs relative to those who did not.

Although JOLs tend to have positive reactive effects for related information, in other cases JOLs have no reactive effect (e.g., England & Serra, 2012; Kelemen & Weaver, 1997; Soderstrom et al., 2015; Tauber & Rhodes, 2012) and can even impair memory performance (Mitchum, Kelley, & Fox, 2016). For instance, Soderstrom et al. (2015) found no JOL reactivity for unrelated word pairs and Mitchum et al. (2016) found negative reactivity for unrelated word pairs. These inconsistent findings may be attributable to methodological differences between studies (e.g., self-paced versus experimenter-paced, use of related versus unrelated word pairs).

Most important, all of the previously discussed research has evaluated JOL reactivity on short-term performance (RIs of 0–3 min). Thus, it is an open question whether reactive effects of JOLs are robust and maintain over time, and answering this question is important for multiple reasons. First, this issue is important theoretically. If making JOLs alters the learning process, then they introduce a confound for researchers focused on the effect of a given independent variable on learning (for a more detailed discussion, see Mitchum et al., 2016). Second, JOL reactivity on long-term learning may be important in applied contexts such as when students study for exams. If JOLs enhance long-term learning, then making them could be an effective learning strategy.

If JOLs strengthen the associative relationship between the cue and target (Soderstrom et al., 2015) then positive JOL reactivity should be apparent on both short-term performance and long-term learning. However, it is also possible that JOLs will not enhance long-term learning. Compared to other effortful learning strategies (e.g., self-testing), JOLs can be made rapidly and do not require effortful processing. This is particularly true with immediate cue–target JOLs, which are used in the present experiments. Further, we know that effortful

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