Title Here: SOMETHING ABOUT DRM AND RELATIONAL ENCODING

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Abstract

[ABSTRACT WILL GO HERE]

Word Count: XXX

*Keywords*: Judgments of Learning; Reactivity; Single Item Lists; DRM Paradigm; Recognition

[TITLE HERE]

When learning new information, it is helpful to assess whether the knowledge being acquired is being encoded effectively. Metamemory, or the processes by which individuals regulate their learning, is a crucial component of learning, as it helps individuals decide whether items need additional study or if they have been sufficiently learned (see Nelson & Narens, 1990). To investigate questions surrounding metamemory, researchers commonly use Judgments of Learning (JOLs), in which participants study a set of items and predict their likelihood of correctly remembering them on a later test (see Rhodes, 2016; Schwartz & Metcalf, 2017, for reviews). While JOLs can be elicited using a variety of scales, participants are commonly instructed to provide these judgments via a continuous 0-100 scale reflecting the probability of correctly remembering an item at test. Thus, JOLs provide a simple measure for assessing how various manipulations affect the study process, including perceptual manipulations (e.g., font; Rhodes & Castel, 2008; Maxwell, Perry, & Huff, 2022) and the presence of associations between items in cue-target pairs (e.g., Koriat & Bjork, 2005; Castel, McCabe, & Rhodes, 2007).

Historically, research involving JOLs has considered these ratings to be neutral measures with no effect on memory, particularly when participants make them concurrently with or immediately following study (though see Spellman & Bjork, 1992, who posited that JOLs made following a delay improved memory for judged items). As such, early work JOL studies often focused on factors influencing their accuracy, rather than their potential effects on memory. However, over the last decade, a growing body of research has demonstrated that JOLs are *reactive* on learning (e.g., Janes, Rivers, & Dunlosky, 2018; Maxwell & Huff, 2022; Soderstrom, Clark, Halamish, & Bjork, 2015; see Double, Birney, & Walker, 2018, for review). Thus, the act of making JOLs modifies participants memory for studied items, likely by making certain features of the stimuli more salient at encoding (Ericsson & Simon, 1993). As a result, eliciting JOLs at encoding could potentially produce memorial benefits (i.e., *positive reactivity*) or costs (i.e., *negative reactivity*), which would be evident when comparing memory performance between participants making JOLs at encoding and a separate group of participants completing a no-JOL control task (e.g., silent reading).

Studies investigating JOL reactivity using cue-target word pairs have revealed a consistent pattern of reactivity: When pairs are related (e.g., mouse – cheese), JOLs improve memory (Janes et al., 2018; Halamish & Undorf, 2023; Maxwell & Huff, 2022; Soderstrom et al., 2015). However, this positive reactivity does not generally extend to unrelated pairs (e.g., mouse – cup), particularly when memory is assessed via cued-recall testing. Instead, JOLs are non-reactive on unrelated pairs (but see Mitchum, Kelley, & Fox, 2016, who showed no reactivity on related pairs and *negative* reactivity on unrelated pairs). To explain the moderating effects of relatedness on JOL reactivity patterns, Soderstrom et al. proposed a cue-strengthening account, which posits that two conditions must be met for reactivity to occur on cue-target pairs. First, studied items must contain intrinsic cues which participants use to inform their JOLs (see Koriat, 1997). Second, participants must be tested using a method that is sensitive to any cues that are strengthened due to making JOLs. Thus, when participants are tested via cued-recall, the cue-strengthening account predicts a memory benefit on related pairs, given that cued-recall testing is highly sensitive to pair relatedness. For unrelated pairs, however, JOLs do not produce a memorial benefit, as intrinsic cue-target relations are not available for this pair type.

While the cue-strengthening account does not explicitly specify the particular cues which JOLs strengthen, it is likely that making JOLs primarily strengthens cue-target relations, given that pair relatedness is a highly salient cue for later remembering (Mueller, Tauber, & Dunlosky, 2013). Given this possibility, recent studies have explored the degree to which relatedness contributes to reactivity. For example, Maxwell and Huff (2022) compared recall for participants making JOLs to three additional encoding groups: A no-JOL control group, a group of participants completing a shallow vowel-counting task instead of providing JOLs, and, importantly, a group of participants who engaged in a deep relational encoding task. Compared to both the no-JOL and shallow encoding groups, JOL participants showed positive reactivity for all related pair types. Critically, participants in the relational encoding group also demonstrated this pattern, even though they were not required to provide JOLs at encoding. Thus, Maxwell and Huff concluded that providing JOLs at encoding encouraged participants process cue-target relations, which led to the implicit adoption of a relational encoding strategy.

Additionally, Halamish and Undorf (2023) recently investigated relatedness effects on on JOL reactivity using related, unrelated, and identical cue-target pairs. In addition to testing differences in cued-recall across pair types, participants also made relatedness judgments at test, in which participants indicated whether cue items had been previously paired with a related, unrelated, or identical target word. Overall, JOLs produced positive reactivity on related but not unrelated pairs, a finding consistent with previous reactivity studies (e.g., Janes et al., 2018; Soderstrom et al., 2015, etc.). Positive reactivity also extended to identical cue-target pairs, further suggesting that perceived relatedness is necessary for reactivity to occur. Importantly, making JOLs also improved the accuracy of relatedness judgments, but only on related pairs. Taken together, these findings suggest that JOLs encourage participants to process relatedness but only for pairs with pre-existing relations.

**JOL Reactivity and List Relatedness**

As noted above, most work investigating JOL reactivity has tested for reactivity patterns using various types of cue-target pairs. This is likely because factors influencing JOLs are often studied within the context of related versus unrelated cue-target pairs, rather than via list-wise manipulations of relatedness (see Chang & Brainard, in press). However, like cue-target relatedness, list relatedness has similarly been shown to affect the magnitude of JOLs. For example, Matvey et al. (2006) had participants make item-level JOLs for words presented in either categorized (i.e., related) or uncategorized (i.e., unrelated) single word lists. Overall, a classic relatedness effect was emerged, such that JOLs were higher for categorized lists relative to uncategorized lists. Similarly, Chang & Brainard replicated this general pattern for JOLs while also demonstrating that items in categorized lists were consistently recalled at a greater rate relative to uncategorized lists. Thus, relatedness effects that are observed on JOLs with cue-target pairs extend to categorized and uncategorized single item lists.

While relatedness has been shown to affect the magnitude of JOLs regardless of whether it is manipulated inter-item (i.e., related and unrelated cue pairs) or when using categorized and uncategorized single-item lists, the mechanisms driving these effects likely differ based on the type of stimuli. Based on Koriat’s (1997) cue-utilization account, making JOLs for cue-target pairs promotes the use of intrinsic cues (i.e., item properties) which participants use to inform their JOLs. Single-item lists, however, encourage the processing of *external* cues, which [WHAT ARE EXTERNAL CUES] Thus, [SUMMARY SENTENCE?]

Regarding JOL reactivity effects, few studies have directly assessed the effects of JOLs memory for single item lists. However, in once exception [SENKOVA & OTANI]

[WORD PAIRS VS WORD LISTS] [ITEM-SEPCIFIC PROCESSES]

**Reactivity and Recognition Testing**

[MYERS ET AL.]

[MAXWELL & HUFF (under review)]

[ZHAO STUDIES?]

**The Present Study**

[DRM LISTS]

[RATIONALE FOR USING SINGLE STUDY LISTS]

**Experiment 1A: Related versus Unrelated Lists and Recognition Testing**

The goal of Experiment 1 was to test [MAIN GOAL]. As such, recognition was compared between three groups: Participants making concurrent, item-level JOLs, a second group who made global JOLs immediately following each study list, or a no-JOL control group. Based on [WHAT DO WE PREDICT?]

**Method**

**Participants**

A total of XX participant were recruited from XX University and completed the study in exchange for partial course credit. Next, an additional XX participants were recruited from Prolific (www.prolic.co) and participated at a rate of $3.00 per 20-minute session. The final sample contained XX participants, and was informed by an a priori power analysis conducted with *G\*Power 3.1* (CITE), which suggested that xx participants would be needed to detect medium main effects and interactions (STATS). All participants were native English speakers, and Prolific participants were additionally required to have obtained at least a high school degree or equivalent.

**Materials**

[CATEGORIZED AND UNCATEGORIZED LISTS]

**Procedure**

[WORDS HERE]

**Results**

[SIGNIFICANCE PARAGRAPH – REFERENCE FIGURE AND APPENDIX] [PBIC?]

[INTRODUCE MODEL]

**Experiment 1B: Related versus Unrelated Lists and Recognition Testing**

Experiment 2 tested [MAIN GOAL – FREE RECALL]. Based on [WHAT DO WE PREDICT?]

**Method**

**Participants**

[WORDS HERE]

**Materials**

[WORDS HERE]

**Procedure**

[WORDS HERE]

**Results**

[REFERENCE FIGURE AND APPENDIX] [INTRODUCE MODEL]

**Discussion**

[WORDS HERE]

**Experiment 2: DRM Lists**

[WORDS HERE]

**Method**

**Participants**

[WORDS HERE]

**Materials**

[WORDS HERE]

**Procedure**

[WORDS HERE]

**General Discussion**

[WORDS HERE]

**Conclusion**

[WORDS HERE]