[TITLE HERE]

The ability for individuals to accurately monitor the progress of their own learning is critical for the successful retention of new information, as effective monitoring allows individuals to maximize retention by adjusting their study strategies (Nelson & Narens, 1990). Metacognitive judgments (i.e., having individuals make judgments about their memorial abilities) can be used to obtain information about the learning process. The Judgment of Learning (JOL) task is a commonly used metacognitive judgment paradigm. In a standard JOL task, individuals are asked to estimate their likelihood of correctly retrieving a target word if shown only the cue on a later memory test. These estimates can be elicited using several types of measurement scales (e.g., Likert Scales or binary “yes-no” responses; Hanczakowski, Zawadzka, Pasek, & Higham, 2013), however, JOLs are commonly elicited using a continuous 0 to 100 scale representing the percent likelihood of the target item being successfully recalled at test (e.g., 100% = definitely would remember; 0% = definitely would not remember). The use of a 100 point scale is beneficial because it allows for an easy comparison between predicted recall (via JOLs) and the proportion of items that are correctly recalled at test.

Though JOL ratings can be accurate and well calibrated with recall, various factors have been demonstrated to show discrepancies between predicted and actual performance. These include perceived ease in identical cue-target word pairs (Castel, McCabe, & Roediger, 2007), increased in time spent studying word pairs (Koriat & Ma’ayan, 2005), and both the direction and magnitude of associative relationships between the cue-target study pairs (Koriat & Bjork, 2005; Maxwell & Huff, in press). The present study contributes to this area by providing an additional test of the relationship between JOLs and correct recall and how this relationship is moderated by associative direction. Additionally, it assess whether item-specific, and relational encoding strategies can improve the relationship between JOLs and correct recall relative to a control group.

Interest in the relationship between memory predictions and accuracy is not a novel area of exploration. For example, in an early study conducted Arbuckle and Cuddy (1969) participants were asked to study letter pairs and say “yes” or “no” to predict if they believed they would remember the pair, then participants were asked to later recall the pairs and say whether their answer was “right” or “wrong”. Overall, this study found that participants, on average, were over 60% right in their predictions of their recall. As such, the authors concluded that participants were able to understand how difficult each pair would be to remember and adjusted their predictions accordingly and that there was a connection between the participants predictions, recall, and the strength of the association in the pairs.

Moreover, research conducted by Koriat and Bjork (2005) supports the notion that both the associative strength and direction of cue-target word pairs affects both the magnitude of JOL ratings and correct recall rates. Specifically, the authors delineated between types two types of associations that were thought to influence the relationship between JOLs and recall. First, *a priori* associations refer to forward associates (e.g., credit-card). The strength of these pair types is rooted in the likelihood that the cue item will elicit the target item at test. As such, a priori association strength can be readily assessed through the use of free association norms (e.g., The University of South Florida Free Association Norms; Nelson, McEvoy, & Schreiber, 2004; The Small World of Words Project; De Deyne, Navarro, Perfors, Brysbaert, & Storms, 2019). These norms are generated free association tasks in which participants are provided with a cue word and are asked to respond with the first target word that comes to mind. These norms can then be used to compute the probability of responding to word A with word B (i.e., forward associative strength, FAS). Second, *a posteriori* associations refer to the perceived relatedness between pairs that are only apparent to participants when words are presented together at study. These pairs can refer to weakly associated pairs (e.g., article-newspaper) or strong associates that in which the pair order has been flipped (i.e., backward pairs, card-credit). Similar to a priori pairs, free association norms can be useful for indexing the backward associative strength (BAS) between pairs (i.e., the probability of responding to word B with word A in an A-B item pairs; see Nelson, McEvoy, & Dennis, 2000 for a review). Thus, a posteriori pairs should have either weak levels of FAS or strong levels of BAS.

To test the correspondence between JOLs and recall for a priori and a posteriori pairs, Koriat & Bjork (2005) conducted three experiments in which participants were presented with a mix unrelated and forward associates (Experiment 1), forward and backward associates (Experiment 2), and unrelated pairs, forward associates, and a set of semantically related a posteriori pairs that shared no association based on norms (Experiment 3). Across each experiment, an *illusion of competence* was detected for a posteriori pairs in which participants’ JOLs exceeded that of subsequent recall. In particular, this effect was most noticeable for the backward pairs presented in their second experiment, as the target items within this pair type do not readily converge upon the cue. Thus, though participants rate backward pairs as likely to be remembered, they are unlikely to correctly recall them at test.

Next, a follow-up study conducted by Castel et al. (2007) showed that the illusion of competence can be extended to include identical word pairs. Participants in Experiment 1 of this study were given a mix of strongly related, weakly related, unrelated, and identical cue-target word pairs and were asked to study the words and provide JOL ratings. Overall, an illusion of competence emerged for identical word pairs in which JOLs exceeded subsequent recall rates. One explanation for this finding is that participants perceived the identical pairs to be easier compared to the other pairs and thus spent less time studying them or because the participants did not encode the identical pairs as deeply because they thought they would be easier to recall (Castel et al., 2007).

More recently, Maxwell and Huff (in press), further investigated the correspondence between JOLs and recall by looking at symmetrical paired associates (e.g., on-off). Symmetrical pairs differ from identical pairs in that they have equal levels of forward and backward associative strength without needing to repeat the same word. Symmetrical pairs are different from forward and backward pairs in that the associative strength between the cue and target word is the same regardless of direction (i.e., salt-pepper would have the same associative strength as pepper-salt), whereas forward and backward cue-target pairs have a stronger strength depending on the direction of the pair (i.e. tuna-fish (F) has a stronger associative strength than fish-tuna (B)). Across four experiments, they found a robust illusion of competence for backward pairs and, additionally, demonstrated that illusion of competence extends to symmetrical associates. Furthermore, Maxwell and Huff showed that the illusion of competence is not contingent upon the type of JOL elicited at study, as the effect replicated across several manipulations designed to mitigate the illusion of competence by increasing the accuracy of JOLs (i.e., having participants make JOLs under experimenter paced study, employing the use of delayed JOLs, etc.). Finally, Maxwell and Huff employed the use of calibration plots in which JOL ratings were plotted against their corresponding recall accuracy Nelson & Dunlosky, 1991), allowing the authors to pinpoint the JOL rating at which the illusion of competence emerged for each pair type.

**Item-Specific-Relational Framework**

One method that has been shown to help improve memory is the use of various encoding strategies at study. These manipulations can take on many forms (e.g., generation tasks, Slamecka & Graf, 1978), however, another commonly used method is to manipulate the way in which participants think about items at encoding (i.e., relating items together, having participants focus on specific details of study pairs, etc.). This can be achieved through the Item-Specific/Relational framework (Hunt & Einstein, 1980; Einstein & Hunt, 1981). This framework proposes that the processes participants engage in at encoding can accentuate either the encoding of the unique facets of each item in a study list (e.g., item-specific processing) or emphasize the shared characteristics of study items (e.g., relational processing). Einstein and Hunt (1981) showed that each strategy was beneficial to memory; however, these benefits were moderated by pair relatedness. Specifically, the memorial benefits of relational processing were highest for unrelated word pairs while item-specific processing had a greater benefit when item pairs were related (Hunt & Einstein, 1981). Relational processing served to create a connection between the features of the unrelated pairs, and item-specific processing served to create an additional relationship for the related pairs, both of which facilitated future recall. Additionally, Hunt and Einstein (1981) found that the benefits of these encoding strategies were dependent upon the context of the words being studied. For example, instructing participants to think about the color of a study pair could either serve to relate the words (i.e., blueness can relate ocean and blueberries) or to separate the words (i.e., blueness can differentiate blueberries from strawberries).

As such, given the benefits of item-specific and relational processing on memory, the present study tested whether these encoding strategies can be used to reduce the illusion of competence found for backward and symmetrical paired associates and unrelated word pairs. Specifically, Experiment 1 compares JOLs and cued-recall performance for each of the aforementioned encoding strategies to a standard JOL control group who receives no explicit encoding instructions. Next, Experiment 2 tests whether combining these encoding manipulation with an explicit warning about the deceptive nature of backward, symmetrical, and unrelated study pairs further reduces the illusion of competence. Finally, across both experiments, we follow the design of Maxwell & Huff (in press) in the use of calibration plots to analyze how well calibrated participants’ JOL ratings are with their correct recall rates and to gauge if participants are over/under confident with their JOL ratings. For Experiment 1, we found that relational encoding increased correct recall for unrelated pairs and that item-specific encoding increased correct recall for backward pairs. For Experiment 2, these effects were replicated, but there was no effect of warning on recall rates. Collectively, this set of experiments shows that having participants engage in additional encoding manipulations at study can be beneficial in reducing the illusion of competence.

**Experiment 1: Item-Specific vs Relational Encoding**

The goals of Experiment 1 were twofold. First, this experiment sought to replicate the illusion of competence for backward, symmetrical, and unrelated pairs for participants completing the silent reading task. Next, it tested whether the encoding manipulations modeled after the Item-Specific/Relational framework (Hunt & Einstein, 1981) could reduce the illusion of competence by either lowering JOL ratings, increasing correct recall, or both. Overall, it was expected that having participants engage in these additional processing tasks at encoding would reduce the illusion of competence by boosting correct recall relative to the control group. Additionally, because relational encoding forces participants to create an association instead of relying on the weak cues between pairs low in FAS, it was expected that this encoding manipulation would be especially beneficial for boosting recall of unrelated pairs. Finally, because item-specific processing has been shown to be more beneficial to memory when pairs are related, it was expected that this encoding strategy would be most beneficial for reducing the illusion of competence for backward and symmetrical pairs.

**Method**

[We’ll paste the methods stuff in here]