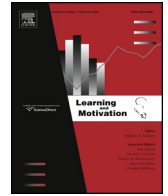




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## Recognition judgments under risk: Low confidence when certainty is low



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### ABSTRACT

Prior research has shown that misleading information about memory probes impairs accuracy in recognition memory tests. Such misleading information also impairs confidence in recognition responses, but for correct rejections only, not for hits. It is unknown whether such effects are preserved when participants face different outcomes according to performance. In the current study, after studying a series of words, participants performed a recognition memory task in which each memory probe could be preceded by a cue forecasting probabilistically the probe's study status ("Likely old" or "Likely new"). Seventy five percent of the cues forecasted accurately the study status of the probes (i.e., valid cues), and 25% inaccurately (i.e., invalid cues). In addition, participants gained or lost points according to whether they made correct or incorrect memory judgments, and received a comestible reward after accumulating 10 of such points. This accumulation scheme was administered in half the study-test blocks. The accuracy/confidence dissociation demonstrated in prior experiments is replicated here. Furthermore, we demonstrate that the decrease in confidence for novel items preceded by invalid cues is accentuated when response accuracy can yield gains or losses. We interpret this confidence decrease for invalidly-cued/rewarded correct rejections as reflecting a combination of loss aversion, as postulated by Prospect theory, and absence of recollection, as postulated by dual process models of recognition.

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### 1. Introduction

A well-known phenomenon in psychology is the greater sensitivity of most people to losses than to gains when making decisions under uncertainty (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). Such loss aversion results in the avoidance of gambles that offer equal chances of gains and losses, except when the amount that can be gained is at least twice as great as the amount that can be lost. Consequently, when faced with decisions with highly uncertain outcomes, people typically attempt to reduce their losses by, for example, making lower bets upon their judgments (Shurger & Sher, 2008). The phenomenon of loss aversion under uncertainty is thought to emerge during decisions performed in various contexts. The possibility of such a phenomenon has yet to be directly examined in the context of recognition memory judgments.

In typical memory recognition tasks, uncertainty can be manipulated by changing the base rates of "old" and "new" items in the test list, a manipulation that makes one of these responses more or less likely than the other (Cox & Dobbins, 2011;

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Estes & Maddox, 1995; Rhodes & Jacoby, 2007; Ratcliff, Sheu, & Gronlund, 1992; Verde & Rotello, 2007; Wallace, 1982). Uncertainty during recognition can also be manipulated by the implementation of payoff matrices that increase or decrease the values of potential gains and losses for each specific response (Curran, Debusse, & Leynes, 2007; Healy & Kubovy, 1978; Van Zandt, 2000). In general, such manipulations do not have a convincing effect on people's responses. Indeed, these studies show that these manipulations do not affect recognition accuracy (e.g., Estes & Maddox, 1995) and do not affect confidence ratings on recognition responses (e.g., Cox & Dobbins, 2011), although they can affect response bias when the characteristics of the manipulation are made very clear for observers (e.g., Verde & Rotello, 2007).

In addition to base-rate manipulations or payoff matrices, uncertainty can be manipulated in recognition tests by explicitly informing participants about the likelihood of each memory probe being "old" or "new" on a trial-by-trial basis. In a recent study in which such manipulation was used, memory probes were preceded by cues ("Likely old" or "Likely new") that forecasted the study status of probes with 75% of certainty (Jaeger, Cox & Dobbins, 2012; see also O'Connor, Han, & Dobbins, 2010; Jaeger, Konkel, & Dobbins, 2013; Jaeger, Selmecky, O'Connor, Diaz, & Dobbins, 2012). Thus, items preceded by the "Likely old" cue had a 75% chance of being actually "old", and a 25% chance of being actually "new". The opposite pattern was true for items preceded by the "Likely new" cue. In a third condition, no cues were available, and participants had to perform recognition judgments based on their memories only.

In the experiments reported by Jaeger, Cox et al. (2012), participants were correctly informed about the proportions of valid and invalid cues and were consequently aware of the old/new base rates under each type of cue. Thus, whenever participants were concordant with the cues (e.g., responding "old" for the "Likely old" cue), the odds that their responses were a priori accurate were 3 to 1. Whenever participants were discordant with the cues, the odds that their responses were a priori accurate were 1 to 3. In the condition in which cues were not available, the odds that any response was a priori accurate were 1 to 1. Thus, when making correct memory judgments, the level of a priori uncertainty for each type of old/new response was significantly increased from validly to invalidly cued trials.

The study reported by Jaeger, Cox et al. (2012) showed that valid cueing increases and invalid cueing decreases accuracy in comparison to uncued trials, suggesting that people indeed consider the likelihood of items being "old" or "new" according to cueing when performing recognition judgments. Furthermore, although for accuracy the valid vs. invalid cueing effect was equivalent for hits and correct rejections, for confidence rates this pattern was strikingly different. While confidence decreased for correct rejections after invalid cueing relative to valid cueing, it was equivalent for both cueing conditions for hits. These confidence patterns were interpreted in light of dual process models of recognition (Yonelinas, 2002), suggesting that recollective processes that were absent during the rejection of novel items raised confidence for hits preceded by invalid cues. The question remains, however, of whether such patterns of accuracy and confidence would be affected when actual gains and losses were conditioned to accuracy. More specifically, the paradigm developed by Jaeger, Cox et al. manipulates certainty/uncertainty on a trial-by-trial basis by presenting cues referring to the probable study status of memory probes. In their experiments, however, the task was in principle risk free, since no actual gains or losses were associated with performance.

Thus, here we conducted an experiment that differs from the experiments reported by Jaeger, Cox et al. (2012) in one critical detail: in half the test blocks, participants gained a point for each correct and lost a point for each incorrect recognition judgment. Every time participants reached 10 points, they were informed that they gained a chocolate candy, and points' counting started from zero again. Thus, in addition to the heightened uncertainty produced by invalid cueing, and in contrast to the Jaeger, Cox et al. study, participants' responses here were not free of consequences (i.e., they could have actual gains or losses according to the accuracy of their responses).

As in the experiments reported by Jaeger, Cox et al. (2012), we also adopted a one-step recognition/confidence judgment. That is, participants made their recognition judgments by responding to a 3-point confidence scale for each response type, ranging from high to low confidence. Thus, since the rejection of novel items is thought to be based primarily on familiarity, we expected that the uncertainty instilled by invalid cueing, in combination with the heightened loss aversion resulting from adding consequences to responses, would result in particularly low confidence rates for this condition. Recollection processes, on the other hand, would make confidence on hits less sensitive to such fluctuations in risk and uncertainty, yielding comparable confidence measures for all hit conditions. In other words, we expected that high uncertainty and loss aversion would decrease confidence for items lacking recollection (novel items) relative to items eliciting recollection (studied items).

## 2. Methods

### 2.1. Participants

Forty undergraduate students (18–36 years old, 21 female) from the University of São Paulo, Brazil, participated voluntarily in the study. Data from one participant were excluded because of misunderstanding of instructions, leaving 39 participants for analysis. Written informed consent was obtained in accordance with the procedures required by the institutional review board of this institution, and in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

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