

Recognition Memory

Method

28 subjects were used. Experiment consisted in 3 training phases, followed by a test phase. In training, for a total of 8 blocks, 4 different types of cue1, 4 different types of cue2, and 2 outcomes were presented. The image displayed in each type of cue was randomly assigned for each participant. Both phase 1 and 2 comprised 1 blocks, whereas phase 3 consisted on 6 blocks. All blocks were a sequence of 20 trials. In each trial, a cue1 and a cue2 were presented, followed by an outcome. In phase 1, there were 2 types of cue1 (1 and 2) and 2 types of cue2 (5 and 6), thus creating 4 different combinations that were repeated 10 times across the phase. Cue 1 was always paired with outcome 1 and cue 2 was always paired with outcome 2, whereas cues 5 and 6 were paired with each outcome half of the times. In phase 2 there were 2 different types of cue1 (3 and 4) and 2 types of cue2 (7 and 8), thus creating 4 different combinations that were repeated 10 times across the phase. Cue 3 was paired with outcome 1 with a 0.8 contingency, being the rest of trials paired with outcome 2. The opposite was true for cue 4, and cues 7 and 8 were paired with each outcome half of the times. In phase 3, the stimuli combinations from the two previous phases were intermixed. The contingencies between cues and outcomes were maintained as in the previous phases. In this training phase, on each trial, the participants had to predict the probable outcome of the cues presented, and the response given as well as the reaction time (RT) were recorded. Based on the programmed contingencies, an additional measure of accuracy was computed, comparing the most probable outcome (that is, the outcome with a higher contingency with cue1) with the response emitted by the participant.

In test phase, the participants were presented each of the 8 cues twice, together with a similar yet new cue, and were asked to choose what cue they had seen before, as well as rating how sure they were of their response. The rating RT was also recorded. A memory score was computed, taking the rating given to the cue in positive when the response was right, and in negative when it was wrong. A corrected version of this score was also computed in order to clean the noise of errors, taking into account just the ratings of the trials in which the participant chose the right stimulus.

Phase 1	Phase 2	Phase 3	Test
AX - O1	0.8CW - O1 / 0.2CW - O2	Phases 1 &2 intermixed	A
AY - O1	0.8CZ - O1 / 0.2CZ - O2		B
BX - O2	0.8DW - O2 / 0.2DW - O1		C
BY - O2	0.8DZ - O2 / 0.2DZ - O1		D
			X
			Y
			W
			Z

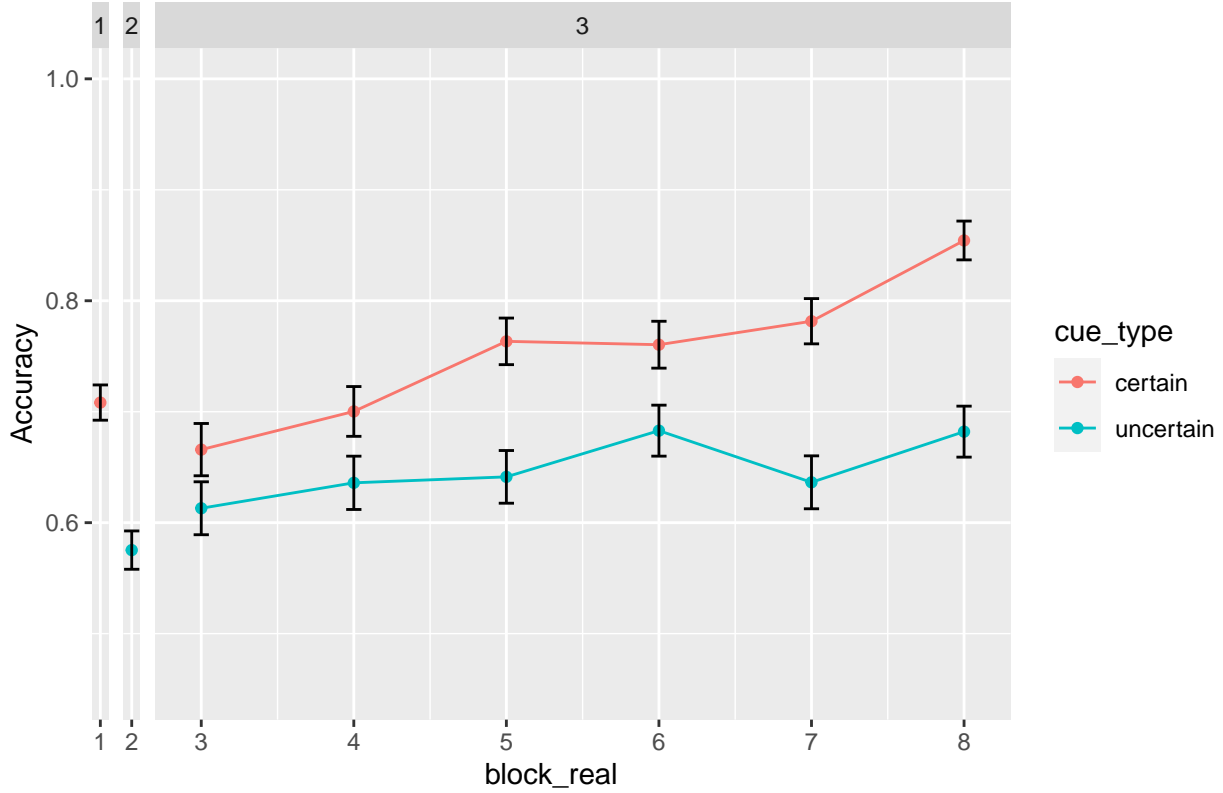
Results

Training phase

As can be seen in the Figure below, the accuracy to the certain cues increased during phase 1, but it seems to decrease again at the start of phase 3, then gradually increasing to reach a value of around 0.85 at the end of training. The accuracy to uncertain cues, although not as better as for the certain groups, increases throughout the training phase, reaching a level of around 0.65 at the end of it.

```
## `geom_line()`: Each group consists of only one observation.
## i Do you need to adjust the group aesthetic?
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## i Do you need to adjust the group aesthetic?
```

Mean corrected accuracy for the 16 block of the three phases of training



Mean responding throughout the experiment was significantly above chance for both certain and uncertain cues, as confirmed by a one sample t test (Certain: $t(81) = 7.10$, $p < .001$, $d = 0.78$, Uncertain: $t(81) = 7.10$, $p < .001$, $d = 0.78$). Also, its worth noting that neither in phase 1 nor phase 2 there were significant differences in responding due to the experiment the data came from ($t(39) = 0.30$, $p = .770$, $d = 0.09$; $t(39) = -0.36$, $p = .719$, $d = -0.11$)

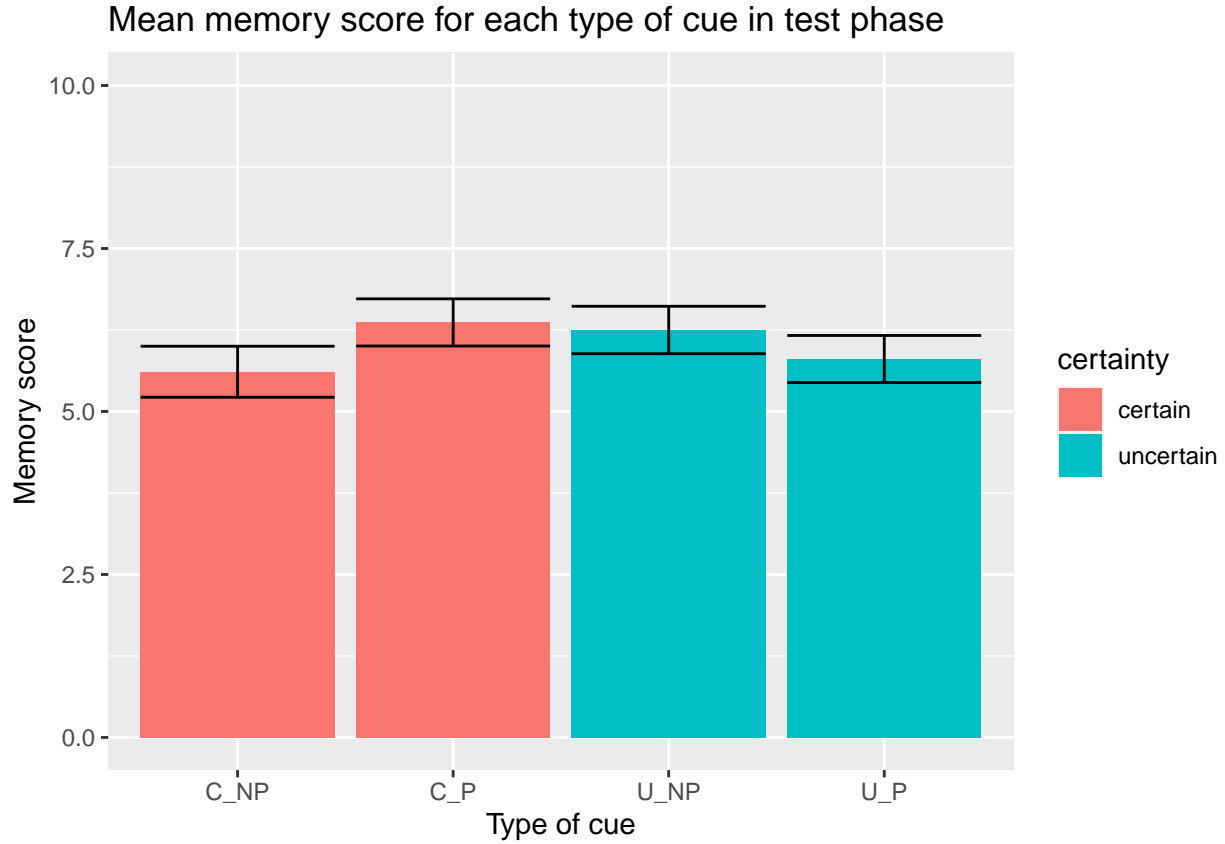
In phase 3, there were no significant effects of the experiment or any of the interactions with that effect (Exp: $F(1, 39) = 0.84$, $p = .365$, $\eta_p^2 = .02$, ExpxBlocks: $F(3.68, 143.60) = 1.96$, $p = .109$, $\eta_p^2 = .05$, ExpxCue: $F(1, 39) = 0.36$, $p = .555$, $\eta_p^2 < .01$, ExpxBlocksxCue $F(5, 195) = 0.87$, $p = .504$, $\eta_p^2 = .02$). Bayesian analysis yielded moderate evidence for the null hypothesis regarding the main effect and the ExpxCue interaction ($BF_{10} = 3.5 \times 10^{-1} \pm 0.91\%$; $BF_{10} = 2.1 \times 10^{-1} \pm 4.26\%$), and very strong evidence for the null hypothesis in the ExpxBlocks and ExpxBlocksxCue interactions ($BF_{10} = 1.5 \times 10^{-1} \pm 1.78\%$; $BF_{10} = 6.9 \times 10^{-2} \pm 3.61\%$). Given that the effect of the experiment did not seem to have a significant effect on the results, they were re-analysed without including the experiment as a factor. Due to this evidence, the effects of the experiment are removed from the following analyses.

A within-subject ANOVA for phase 3 yielded significant differences for all effects, being the evidence very strong for both the blocks and the cue, but moderate in favor of the null for the interaction (Block: $F(3.76, 150.45) = 7.11$, $p < .001$, $\eta_p^2 = .15$, $BF_{10} = 5 \times 10^2 \pm 0.53\%$; Cue: $F(1, 40) = 21.27$, $p < .001$, $\eta_p^2 = .35$, $BF_{10} = 9.3 \times 10^8 \pm 2.54\%$; interaction: $F(5, 200) = 2.36$, $p = .041$, $\eta_p^2 = .06$, $BF_{10} = 2 \times 10^{-1} \pm 2.41\%$). This indicates that all subjects improved their performance as training progressed, and that accuracy was better for certain than uncertain cues, especially at the end of the experiment.

Test phase

Mem score

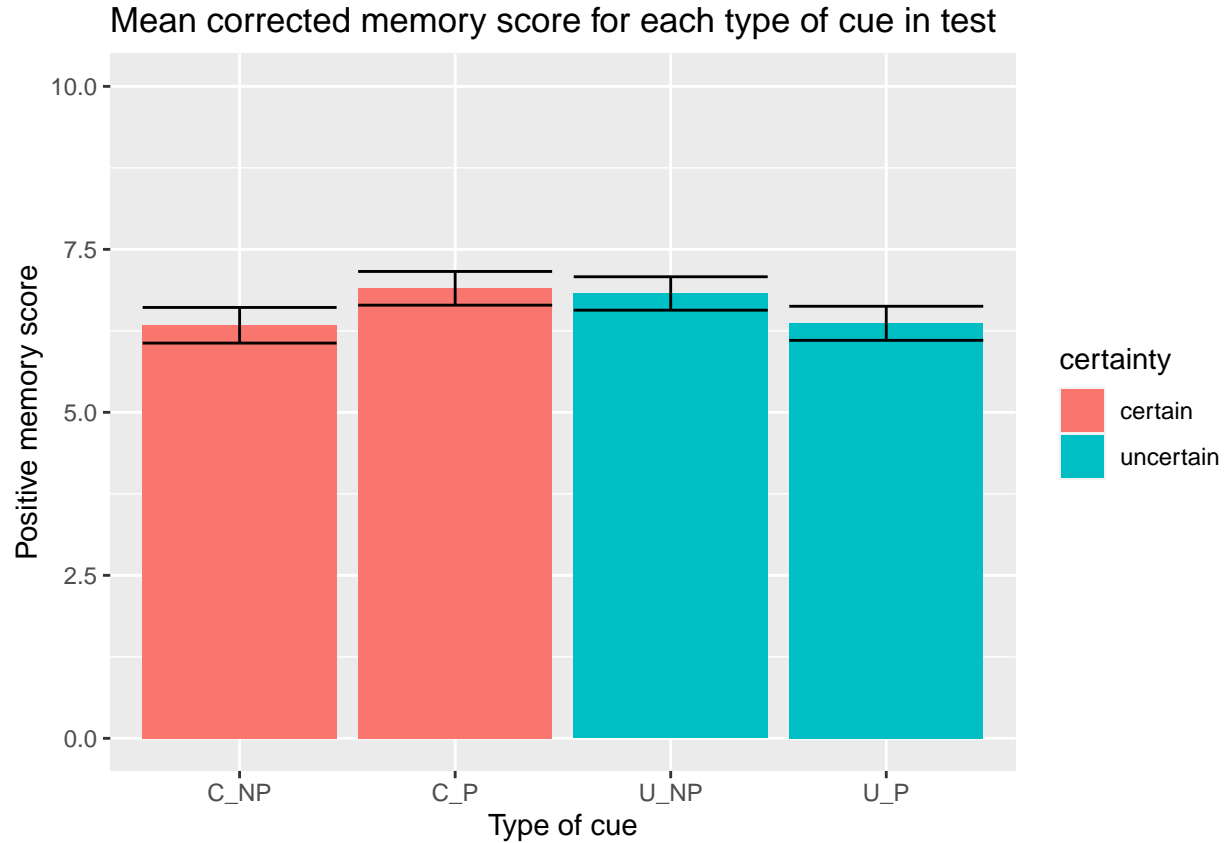
In the figure below, it can be seen that the memory score was the highest for the certain predictive cues, followed by the uncertain non predictive cues, then uncertain predictive cues, and finally, the certain non-predictive cues had the lowest memory score, but the differences were very subtle.



In the test stage, nor the main effect of the experiment nor any of its interactions were significant (Exp: $F(1, 39) = 0.01$, $p = .935$, $\eta_p^2 < .01$, ExpxCertainty: $F(1, 39) = 0.00$, $p = .972$, $\eta_p^2 < .01$, ExpxPredictiveness: $F(1, 39) = 0.01$, $p = .922$, $\eta_p^2 < .01$, ExpxCertaintyxPredictiveness: $F(1, 39) = 1.14$, $p = .292$, $\eta_p^2 = .03$). The evidence for a null effect of the effect of the experiment and its interactions with certainty and with predictiveness was moderate (Exp: $BF_{10} = 2.6 \times 10^{-1} \pm 0.74\%$, ExpxCertainty: $BF_{10} = 2.3 \times 10^{-1} \pm 2.74\%$, ExpxPredictiveness: $BF_{10} = 2.2 \times 10^{-1} \pm 5.87\%$), whereas regarding the threeway interaction there was only anecdotal evidence for the null hypothesis (ExpxCertaintyxPredictiveness: $BF_{10} = 4.8 \times 10^{-1} \pm 10.87\%$). Due to this, the effect of the experiment was removed from further analyses.

When the analysis was repeated without taking into account the effect of the experiment, no significant main effects nor interaction were found (Certainty: $F(1, 40) = 0.01$, $p = .920$, $\eta_p^2 < .01$, Predictiveness: $F(1, 40) = 0.17$, $p = .686$, $\eta_p^2 < .01$, CertaintyxPredictiveness: $F(1, 39) = 3.03$, $p = .090$, $\eta_p^2 = .07$). However, the evidence in favor of the null hypothesis for both the main effect of certainty and predictiveness was moderate ($BF_{10} = 1.7 \times 10^{-1} \pm 1.75\%$, $BF_{10} = 1.8 \times 10^{-1} \pm 1.9\%$), being the evidence for the null effect of the interaction anecdotal ($BF_{10} = 6 \times 10^{-1} \pm 6.06\%$).

Corrected memory (hits x1, errors x0)

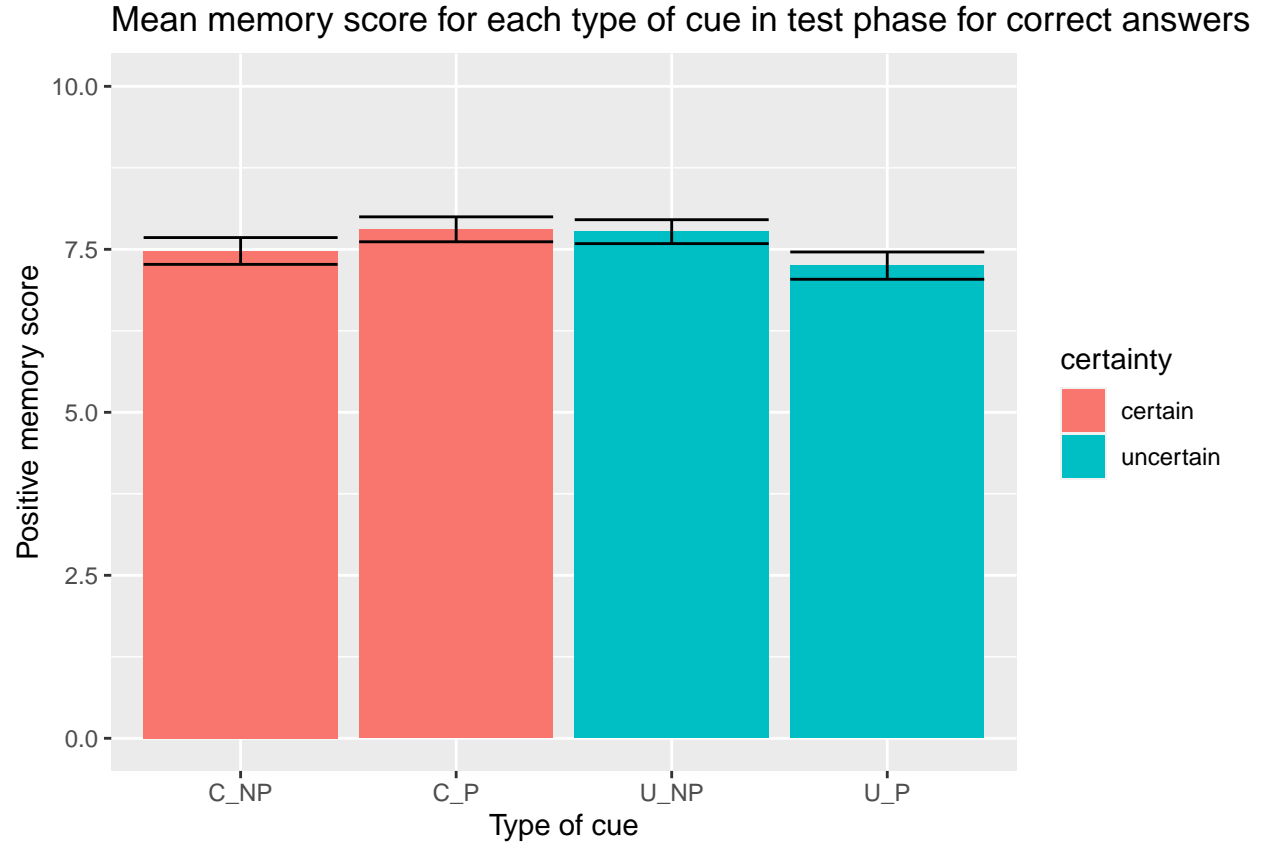


In the test stage, nor the main effect of the experiment nor any of its interactions were significant (Exp: $F(1, 39) = 0.18, p = .670, \eta_p^2 < .01$, ExpxCertainty: $F(1, 39) = 0.01, p = .916, \eta_p^2 < .01$, ExpxPredictiveness: $F(1, 39) = 0.04, p = .852, \eta_p^2 < .01$, ExpxCertaintyxPredictiveness: $F(1, 39) = 0.09, p = .768, \eta_p^2 < .01$). The evidence for a null effect of the experiment and the threeway interaction was anecdotal and the evidence for the interactions with certainty and with predictiveness was moderate (Exp: $BF_{10} = 3.2 \times 10^{-1} \pm 0.92\%$, ExpxCertainty: $BF_{10} = 2.5 \times 10^{-1} \pm 2.98\%$, ExpxPredictiveness: $BF_{10} = 2.5 \times 10^{-1} \pm 5.27\%$), whereas regarding the threeway interaction there was only anecdotal evidence for the null hypothesis (ExpxCertaintyxPredictiveness: $BF_{10} = 2.6 \times 10^{-1} \pm 20\%$). Due to this, the effect of the experiment was removed from further analyses.

The absence of differences was confirmed by the results of the ANOVA, that yield no significant effect of the certainty or predictiveness the cue, neither their interaction ($F(1, 40) = 0.01, p = .930, \eta_p^2 < .01$, $F(1, 40) = 0.04, p = .838, \eta_p^2 < .01$, $F(1, 40) = 3.42, p = .072, \eta_p^2 = .08$, respectively). There was moderate evidence that the main effects were non significant ($BF_{10} = 1.7 \times 10^{-1} \pm 1.2\%$, $BF_{10} = 1.7 \times 10^{-1} \pm 1.63\%$), and anecdotal evidence that the interaction was significant ($BF_{10} = 1.1 \times 10^0 \pm 6.46\%$). This indicated that all the cues were remembered similarly.

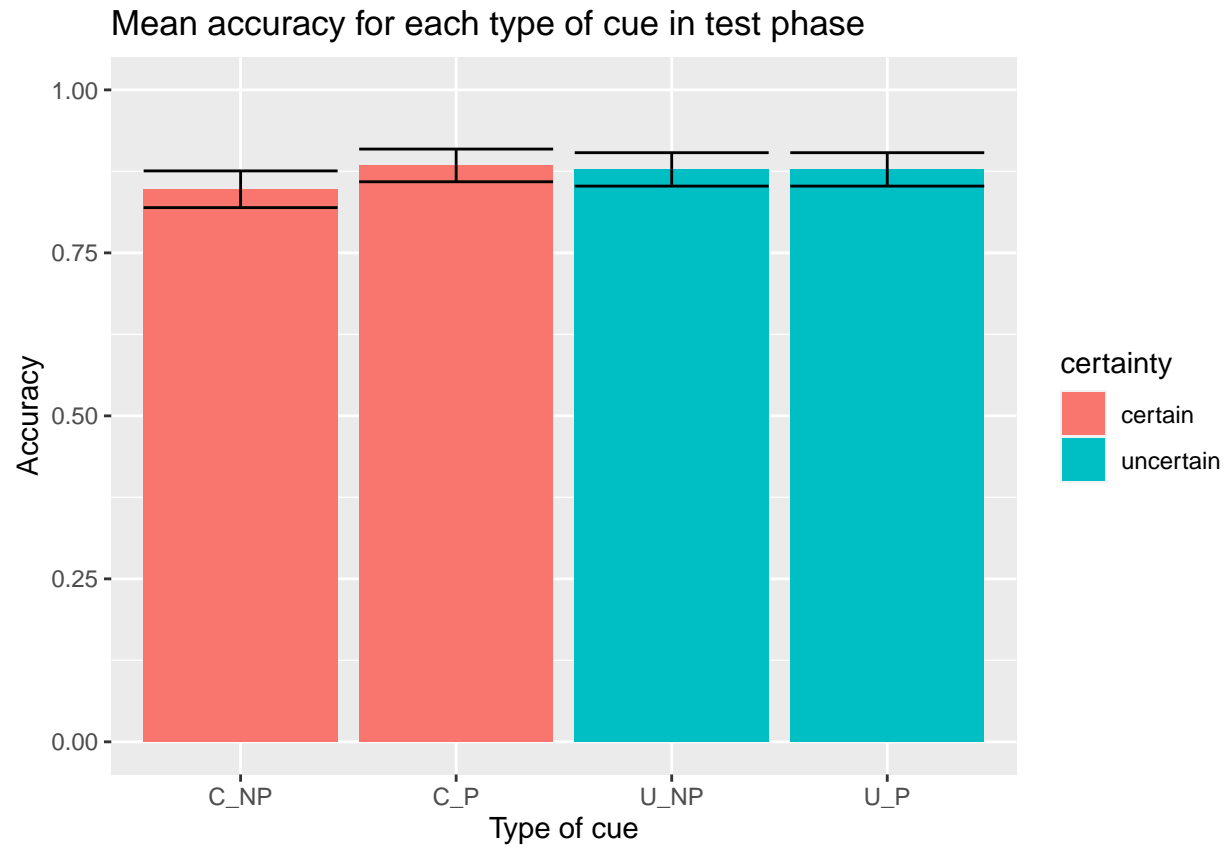
Corrected memory (errors out)

Let's analyse only with the correct responses in the memory score.



With this measure, no significant effects were found, but the evidence was moderate in favor of the null hypothesis for the main effects and anecdotal for the interaction (Certainty: $F(1, 40) = 0.23$, $p = .635$, $\eta_p^2 < .01$, $BF_{10} = 1.8 \times 10^{-1} \pm 1.12\%$; Predictiveness: $F(1, 40) = 0.39$, $p = .536$, $\eta_p^2 < .01$, $BF_{10} = 2 \times 10^{-1} \pm 1.56\%$; interaction: $F(1, 40) = 3.78$, $p = .059$, $\eta_p^2 = .09$, $BF_{10} = 6 \times 10^{-1} \pm 6.06\%$).

Accuracy



With this measure, no significant effects were found, with all the evidence being moderate in favor of the null hypothesis (Certainty: $F(1, 40) = 0.22$, $p = .643$, $\eta_p^2 < .01$, $BF_{10} = 1.8 \times 10^{-1} \pm 1.21\%$; Predictiveness: $F(1, 40) = 0.44$, $p = .509$, $\eta_p^2 = .01$, $BF_{10} = 2 \times 10^{-1} \pm 0.64\%$; interaction: $F(1, 40) = 0.37$, $p = .547$, $\eta_p^2 < .01$, $BF_{10} = 2.8 \times 10^{-1} \pm 2.74\%$).