Detection in Context - pre-registration document

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Abstract

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# 1 Motivation

Perceptual decisions are influenced not only by incoming sensory input, but also by our own expectations and motivations. For example, stimuli that are predictable in a given context appear sharper (Rossel, Peyrin, Roux-Sibilon, & Kauffmann, 2022) and are more likely to be perceived when presented at near-threshold intensity (Reznik, Henkin, Schadel, & Mukamel, 2014; Yon, Zainzinger, Lange, Eimer, & Press, 2020). Apparently opposite effects are also sometimes observed, whereby expected events are perceived less readily than their unexpected counterparts (Press, Kok, & Yon, 2020). There are many unanswered questions concerning what contributes to the influence of expectations on perceptual experience. One likely contributing factor concerns whether subjects belive (explicitly or implicitly) that they will detect expected or unexpected events more readily, and whether they are able to utilize these beliefs in guiding their information gathering behaviour.

We can understand this by probing decisions about the absence of objects and stimuli. We often rely on the absence of positive evidence inferring absence; instead of directly perceiving absence, we need to infer that we would have perceived the object if it were present (Mazor, 2021; Mazor & Fleming, 2022). The roles of counterfactual reasoning and self-knowledge in decisions about absence make it a unique opportunity to ask what aspects of their perception and cognition do subjects represent in their mental self-models, and what aspects are misrepresented, or not represented at all. Here we focus on the effects of expectation on perception. We will contrast near threshold detection performance in contexts that are either matching or non-matching with the target stimulus, and quantify the effects of expectation on detection, and more importantly, on the ability to efficiently infer absence. We will focus on the novel question of whether absence is more efficiently detected in a context congruent or incongruent to the presence of that stimulus.

# 2 Methods

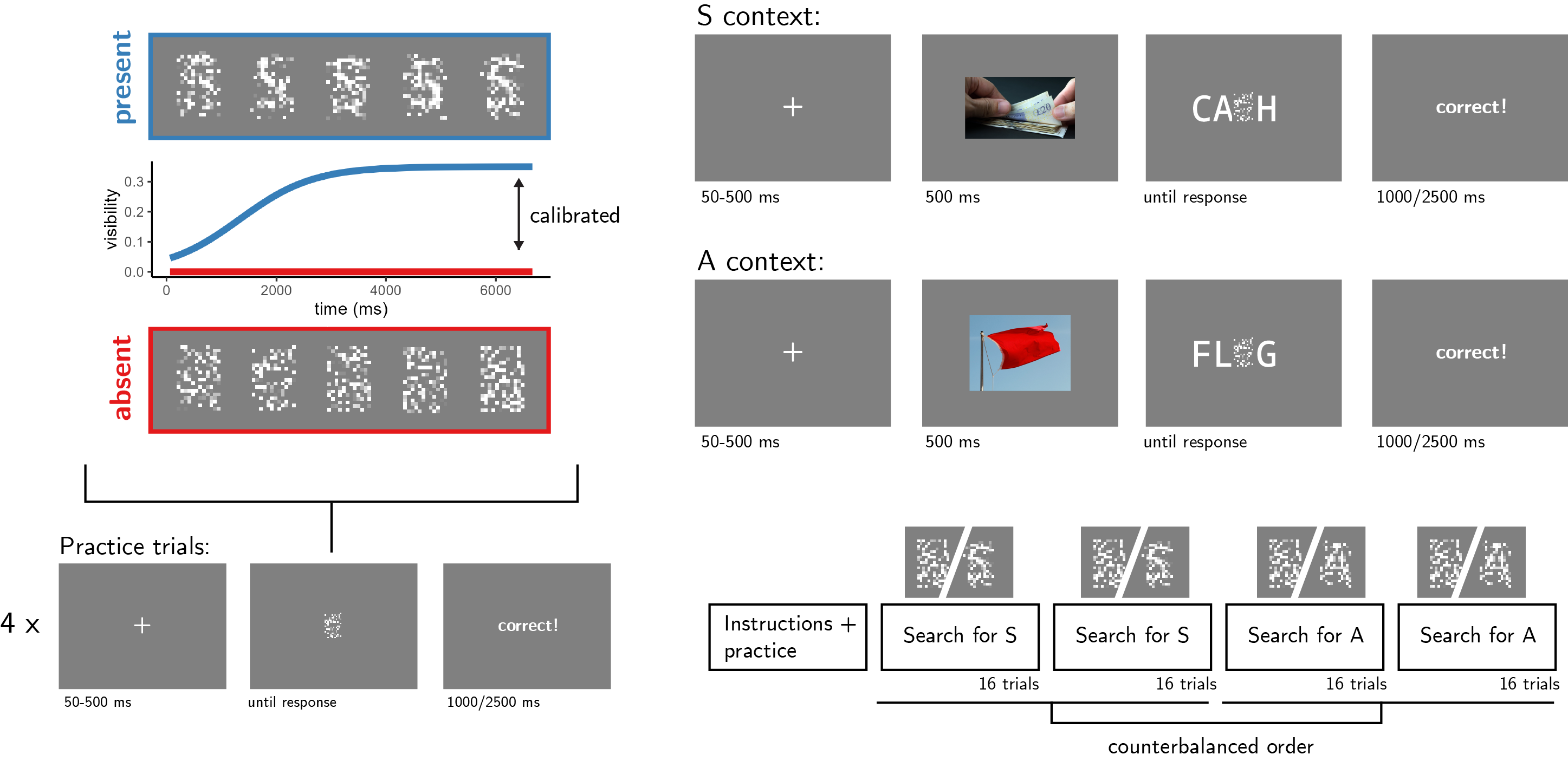
We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

## 2.1 Participants

The research complies with all relevant ethical regulations, and was approved by the Research Ethics Committee of Birkbeck, University of London (study ID number 1812000). Participants will be recruited via Prolific, and will give informed consent prior to their participation. To be eligible to take part in this study, their Prolific approval rate will need to be 95% or higher, their reported first language English, and their age between 18 and 60. We will collect data until we reach 100 included participants (after applying our pre-registered exclusion criteria). The entire experiment will take 11 minutes to complete. Participants will be paid £1.38 for their participation, equivalent to an hourly wage of £7.50.

## 2.2 Procedure

Participants will detect the presence or absence of a target letter (S or A, in different blocks) in a patch of dynamic grayscale noise presented at 15 frames per second. In each frame, noise will be generated by randomly sampling grayscale values from a target image . Specifically, for each pixel , we will display the grayscale value for the corresponding pixel in the original image with some probability , and the grayscale value of a randomly chosen pixel with probability . On target-absent trials, will be set to , such that they grayscale values of all pixels will be randomly shuffled. On target-present trials, the probability will slowly increase as the trial progresses, according to the formula with representing the frame number, and the maximum visibility level (see Fig. 1). will be calibrated online to achieve performance levels of around 80%, following a 1-up-3-down procedure, starting at and following a multiplicative set size of , which will move closer to 1 following each change direction in the calibration process. Responses will be delivered using the F and G keyboard keys, and response-mapping will be counterbalanced across subjects.



*Figure* *1.*  Experimental design. Top left: target visibility as a function of frame number for in target present (blue) and target absent (red) trials. Bottom left: trial structure in practice trials. Top right: trial structure in the main blocks of the experiment, in S- and A- context trials. Bottom right: overall experiment structure.

After reading the instructions, participants will complete four practice trials. In case their accuracy in these four practice trials falls below 3/4, they will be reminded of task instructions and given additional practice trials, until they reach the desired accuracy level. Otherwise, they will continue to the main part of the experiment. Here, their task will be exactly the same, but the noise patch will be embedded in a congruent or incongruent context word. For example, when searching for the letter S, the context word CA\_H (cash) is congruent but the context word FL\_G (flag) is not (see Fig. 1, upper right panel). To make sure participants are primed with the correct reading of the context word, an image of its meaning will be presented for 500 ms following the fixation cross and prior to the presentation of the noise display.

The main part of the experiment will comprise four blocks of 16 trials. For approximately half of the participants, in blocks 1 and 2 the target letter will be S and in blocks 3 and 4 it will be A. The order of letters will be reversed for the other half. All context words will be presented twice: once when detecting the letter S and once when detecting the letter A. As a result, all context words will be presented both as congruent and as incongruent contexts for the target letter. Overall, there will be 32 context words: 16 where the missing letter is an A and 16 where it is an S. All words will be 4- or 5-letter nouns with S or A in one of the central positions (i.e., position 2 or 3 in 4-letter words and position 3 in 5-letter words).

### 2.2.1 Randomization.

The order and timing of experimental events will be determined pseudo-randomly by the Mersenne Twister pseudorandom number generator, initialized in a way that ensures registration time-locking (Mazor, Mazor, & Mukamel, 2018).

## 2.3 Data analysis

### 2.3.1 Rejection criteria.

Participants will be excluded if their accuracy falls below 50%. We will also exclude participants for having extremely fast or slow reaction times in one or more of the tasks (below 100 milliseconds or above 5 seconds in more than 25% of the trials).

Trials with response time below 100 milliseconds or above 5 seconds will be excluded from the response-time analysis.

### 2.3.2 Hypotheses and analysis plan.

This study is designed to test several hypotheses about the effects of expectation and context on visual detection, with a focus on the timing of decisions to terminate evidence accumulation in the absence of a target as a potential window into self-modeling and metacognitive knowledge about perception and attention.

Specifically, we plan to test the following hypotheses:

*Hypothesis 1 (PRESENCE/ABSENCE RESPONSE TIME)*: We will test the null hypothesis that response times are similar for target-absent and target-present responses, aiming to replicate the finding that decisions about the absence of a target are slower than decisions about its presence (Mazor, Friston, & Fleming, 2020; Mazor, Moran, & Fleming, 2021). This will be tested using a paired t-test on the median individual level-response times.

*Hypothesis 2 (CONTEXT IN PRESENCE)*: We will test the null hypothesis that target-present response times are similar when the context word matches or does not match the target letter. This will be tested using a paired t-test on the median individual level-response times .

*Hypothesis 3 (CONTEXT IN ABSENCE)*: We will test the null hypothesis that response times in target-absent responses are similar when the context word matches or does not match the target letter. This will be tested using a paired t-test on the median individual level-response times.

*Hypothesis 4 (CONTEXT RESPONSE INTERACTION)*: We will test the null hypothesis that the effect of context on reaction time is similar in target-absent and target-present responses. This will be tested by performing a group-level t-test on the subject-level contrast Where , , and stand for present, absent, congruent (matching) and incongruent (non-matching), respectively.

*Hypothesis 5 (SENSITIVITY)*: We will test the null hypothesis that sensitivity (measured as d’) is equal in matching and non-matching contexts. To allow the extraction of d’ for participants who committed no false-alarms or misses, we will add 0.5 to miss, hit, false-alarm and correct rejection counts (Snodgrass & Corwin, 1988).

*Hypothesis 6 (CRITERION)*: We will test the null hypothesis that decision criterion (measured as c) is equal in matching and non-matching contexts. To allow the extraction of a decision criterion for participants who committed no false-alarms or misses, we will add 0.5 to miss, hit, false-alarm and correct rejection counts (Snodgrass & Corwin, 1988).

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