Varying cue-stimulus interval negligibly affects the sensory discrimination performance in the antisaccade task

Does attention in perceptual tasks change over time?

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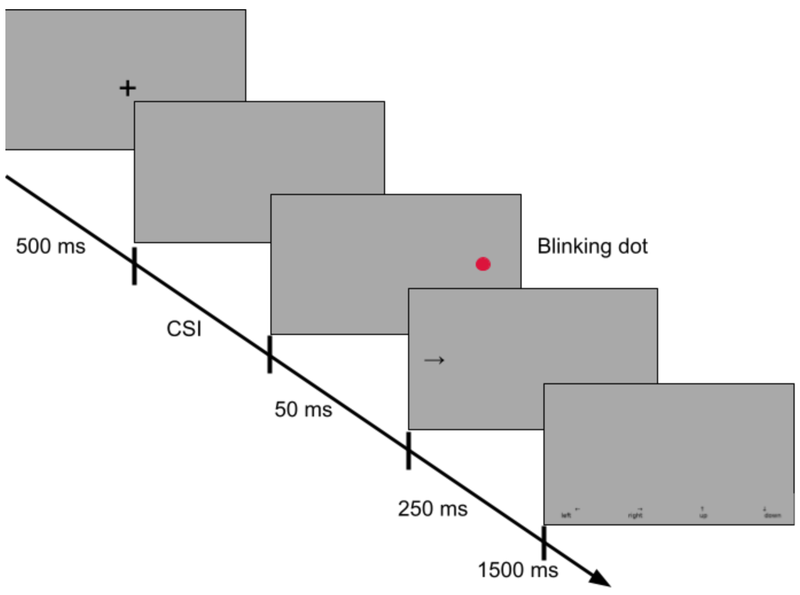
Introduction

Whether the stimulus discrimination performance `increases` (e.g., due to goal strengthening), `decreases` (e.g., due to vigilance decay), or `varies periodically` (e.g., along attentional rhythms) as a function of time elapsing between task onset (fixation point, cue) and stimulus (cue-stimulus interval; CSI) is debated in the current literature on attention, and so far the findings are equivocal.

Method

In order to precisely examine the role of CSI in stimulus discrimination, we used the classic `antisaccade task` with CSI varied in `millisecond steps`. On each trial, participants were shown for 250 ms either `left or right arrow` as a target, and their task was to indicate which arrow was displayed by `pressing the appropriate key`. The arrows were randomly displayed on either the left or right side of the screen. The stimulus was accompanied by a `red dot` briefly flashing on the opposite side of the screen, which should be ignored. The fixation point and the red dot/stimulus presentation were separated by a `blank screen` shown for CSI ranging.



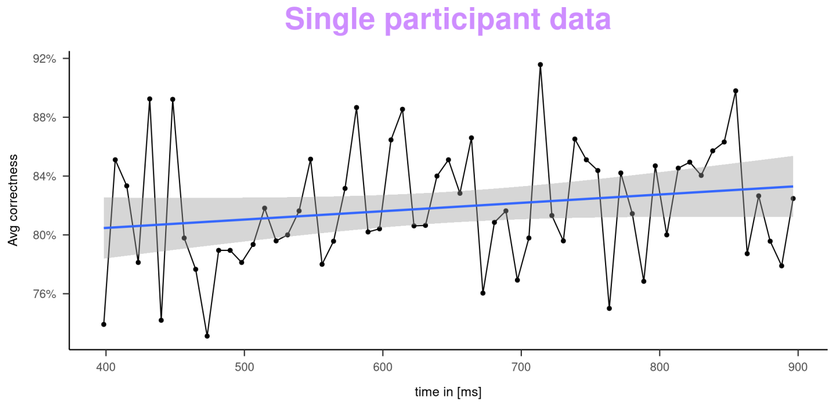
Datasets

We conducted two experiments, one with lower resolution (less trials per participant) but a larger sample and the other with higher resolution but a smaller sample.

Param	Bigger low-res	Smaller high-res
N	150	40
Sampling freq	60 Hz	120 Hz
CSI Step	16.6 ms	8.3 ms
CSI Range	350-1000 ms	400-900 ms
Unique CSI's	40	61
Reps per CSI	11	104
Trials	440 per person	6344 per person

For each participant, the mean accuracy was calculated for each CSI timepoint. These mean accuracy values were plotted as a function of increasing CSI, with a single curve created for each person.

Single participant data



Results

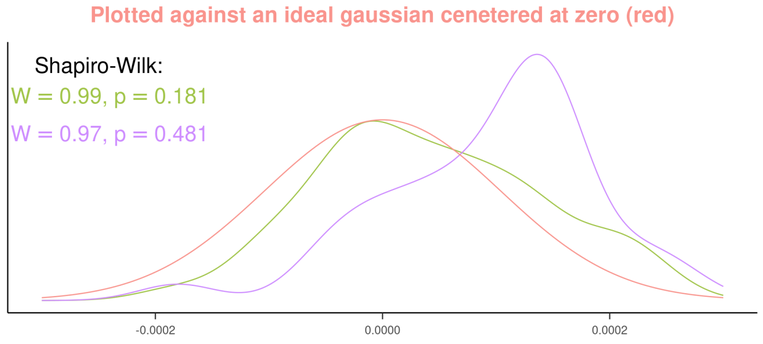
The curves described above were used to analyze the potential presence of an increasing or decreasing `trend`, and a `periodic variation`.

Trend

The first analysis consisted of fitting a regression line for each participant. The slopes of the fitted regression were then subjected to a one-sample t-test comparing their mean with the zero value.

Beta coefs. distribution

Plotted against an ideal gaussian cenetered at zero (red)



The colored curves represent beta variable distribution for bigger low-res and smaller high-res datasets respectively. Both curves did not show evidence of non-normality and are showing significant difference from a zero distribution ($p<.001$). However, both effects are, in our opinion, negligibly small (4.15% and 4.58% of increased avg. accuracy over 1000 ms).

Periodic variation

The periodicity analysis was performed on the frequency spectrum of smaller high-res dataset calculated for each participant using the `Fourier transform`. Periodicity would be detected when the power of any of the examined frequency bands was significantly higher than the random level. The mean correctness for each subject was `permuted 10,000 times`, creating artificial signals that were then Fourier-transformed. Thus, the power distribution of each frequency band in the absence of periodicity was known. The comparison of the power obtained in the experiment with the permutationally determined random level was done using both `Holmes adjusted` and raw directional p-tests.

Frequency [Hz]	Estimate	p value	p adj
0.000	0.086	0.850	>.99
1.277	0.435	0.300	>.99
2.553	0.612	0.990	> .99
3.830	0.661	0.760	> .99
5.106	0.603	0.100	> .99
6.383	0.537	0.820	> .99
7.660	0.573	0.950	> .99
8.936	0.554	0.960	> .99
10.213	0.542	0.750	> .99
11.489	0.602	0.230	> .99
12.766	0.590	0.740	> .99
14.043	0.595	0.280	> .99
15.319	0.555	0.650	> .99
16.596	0.639	0.054	> .99
17.872	0.607	0.350	> .99
19.149	0.535	0.910	> .99
20.426	0.548	0.860	> .99
21.702	0.601	0.470	> .99
22.979	0.592	0.410	> .99
24.255	0.516	0.440	> .99

Conclusion

We conclude that the correctness of solving the anti-saccade task `does not oscillate in the CSI function` but shows `a small trend effect`. These findings contradict some of the literature on behavioral oscillations. We are planning further experiments to explain this phenomenon in wider CSI intervals, `up to 3000 ms`.