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What do the eyes tell us about our inhibition ability?

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1 Introduction

1.1 Context

In ocular movement research, saccade trajectory deviation is used to operationalize the visual aspects of attention and cognitive control (Tudge et al., 2017). The modification of saccade trajectory is thought to result from the mechanisms underlying eye movement, as well as the dynamics of the oculomotor system (Van der Stigchel et al., 2006). Indeed, it has been suggested that eye movement trajectories may reflect the competition between bottom-up and top-down processes involved in visual attention (Van der Stigchel et al., 2007).

1.2 Aim of the study

The work of Godijn and Theeuwes (2002) on saccade trajectories was replicated in order to acquire skills on eye tracking methods and analyses. Next, to deeper bottom-up and top-down competition mechanisms and to explore processes involved in the ability to inhibit goal-irrelevant information, a modified version of the Oculomotor Capture Task was used. The objective was to generate further research questions on the basis of the acquired results and skills.

1.3 Further research questions

Important inter-individual differences were observed for most oculomotor parameters analysed in this study, suggesting a highly variable manner in which the space is processed to perform on the task. Inter-individual differences seem to be often overlooked, as it is the case in the study we sought to replicate. Beyond this replication effort, the possible sources of this variability will be adressed, as well as the advantages that could be taken of these differences to (1) provide further insight into the results of the present study, and (2) open new perspectives for studies using other physiological measures (e.g. EEG).

2 Methods

2.1 Participants and Procedure

- 17 participants (14 females; mean age = 20.8 years, SD = 2.3 years, range 18 to 27 years)
- A modified version of the Oculomotor Capture Task (*Figure 1*)
- 1152 randomized trials: 50% with onset distractor, 50% without onset distractor

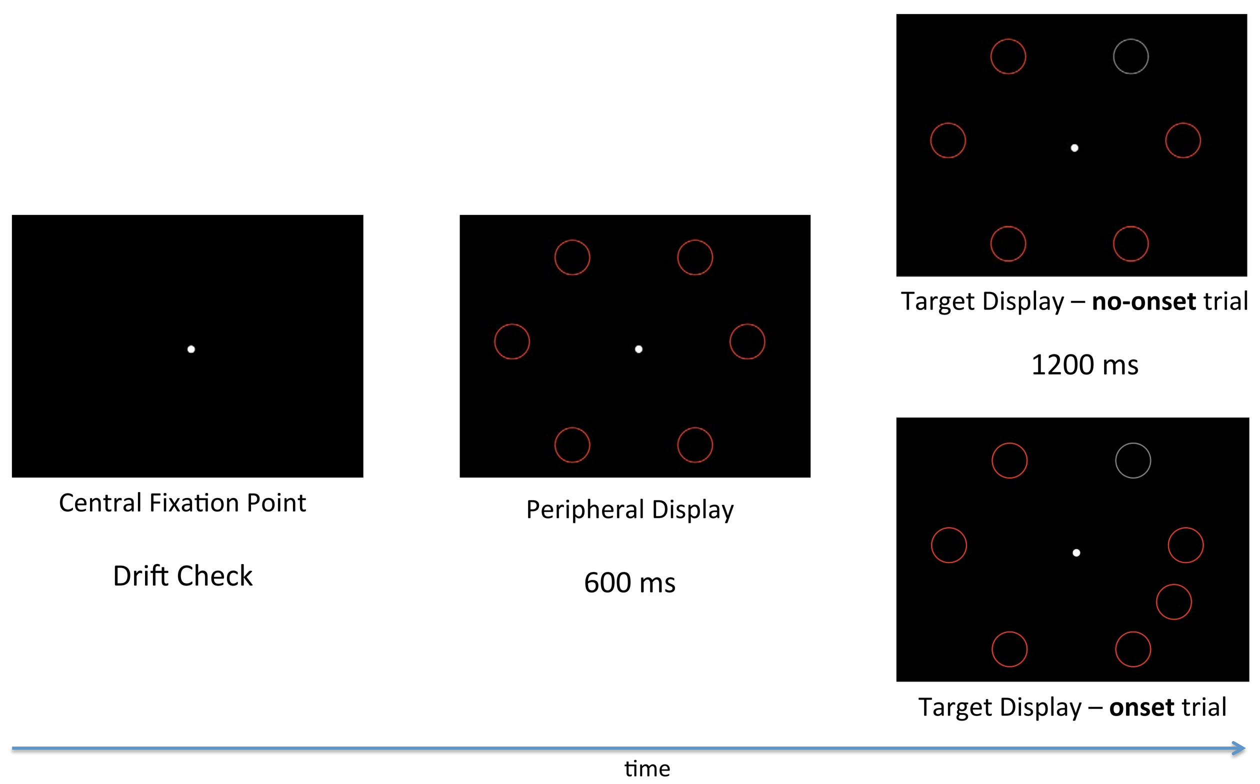


Figure 1: Trial design: a fixation point was first presented on a black display. As soon as the gaze of the participant was on the fixation point, the experimenter validated the drift check. This was followed by a peripheral display, containing 6 red circles around the fixation point. After a delay of 600 ms, the target display appeared for 1200 ms. On this display, one of the red circles turned grey, and it represented the target to which participants were asked to direct their gaze as fast as possible. In half of the trials, an additional red circle representing an onset distractor was added (onset trials), while in the remaining trials, only the target was presented (no-onset trials).

2.2 Apparatus

EyeLink tracker (1000 Hz temporal resolution and 0.2° spatial resolution)

3 Results (replication)

3.1 Initial saccade destination and latency

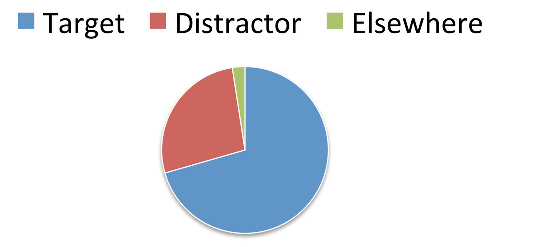


Figure 2: Initial saccade destination (% on either target, distractor, or elsewhere.

- On the no-onset trials, 97.7% of the initial saccades were directed to the target, and 2.3% went elsewhere
- On the onset trials (90° or 150° of angular separation from target), 70.5% of the initial saccades were directed to the target, 27% were directed to the distractor, and 2.4% went elsewhere
- On the onset trials, initial saccades had shorter latencies when they were directed to the onset distractor (M = 192 ms) than when they were directed to the target (M = 280) (t(16) = 16.4, p < .001)

3.2 Saccade latency distributions

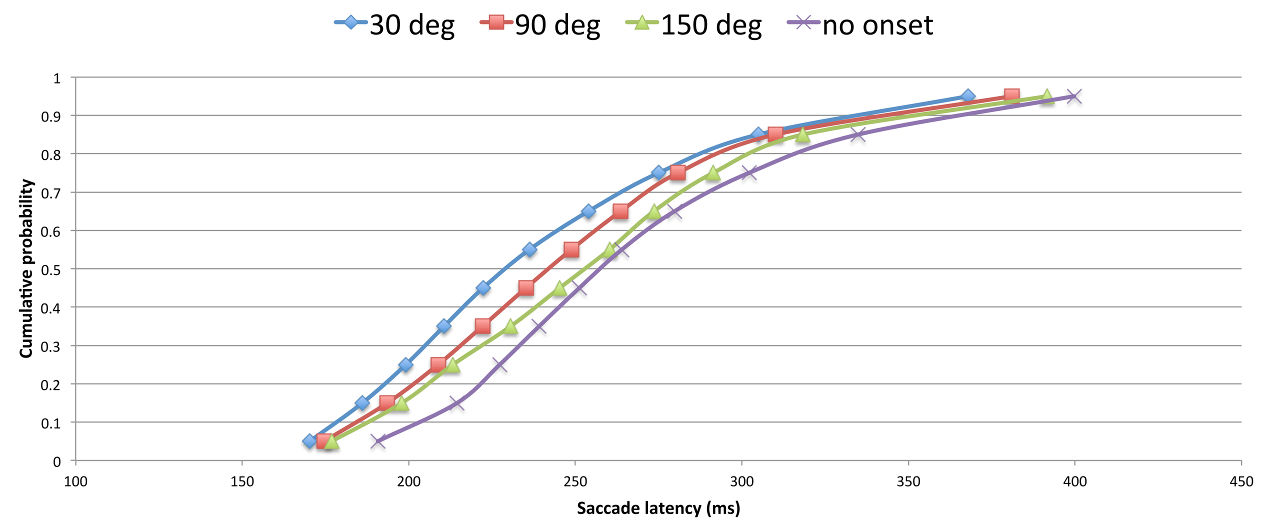
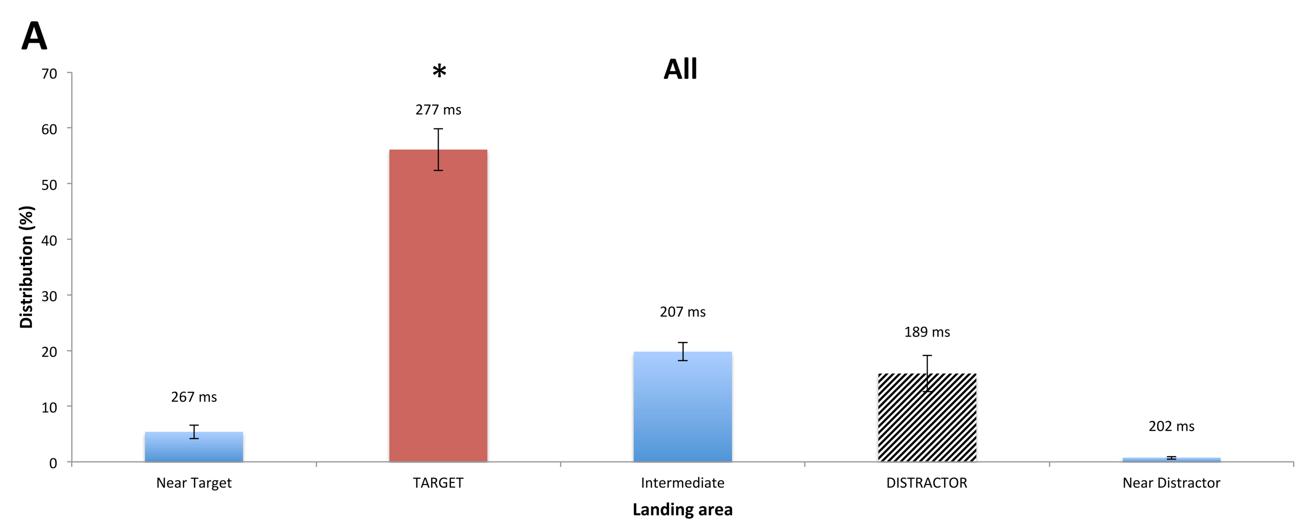


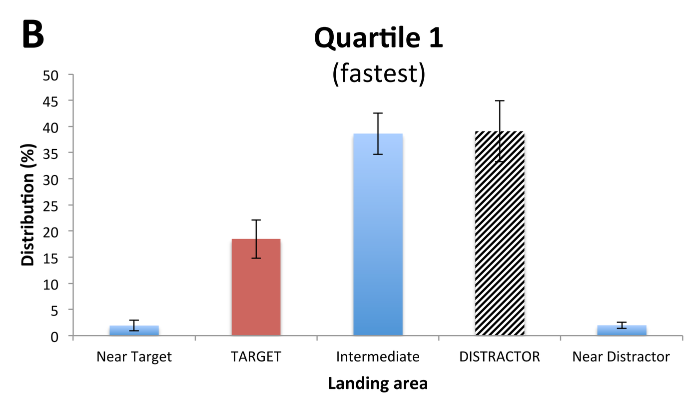
Figure 3: Cumulative distribution functions of the latency of the first saccade irrespective of saccade destination. deg = degrees.

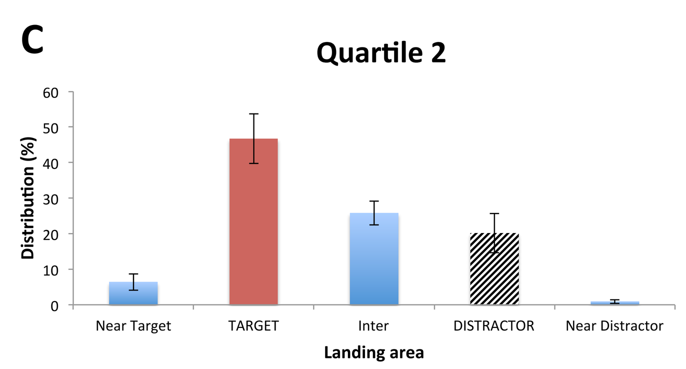
- A within-subjects ANOVA with angle separation (30°, 90°, and 150°) and bin (10 deciles) as factors revealed a main effect of angle separation ($F(2)$ = 14.41, p < .001)
- Saccade latency was shorter in the 30° condition than in the 90° (p = .015) and 150° (p = .002) conditions
- Saccade latency was shorter in the 90° than in the 150° condition (p = .019)
- Saccade latencies were shorter in the 30° (p < .001) and 90° (p < .001) conditions than in the no-onset condition

3.3 Saccade endpoints in the 30° separation condition (global effect)

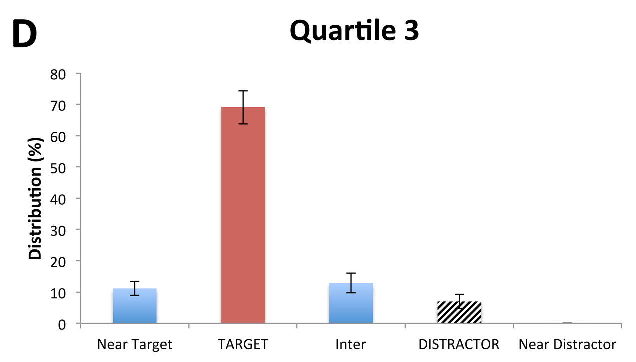


- A within-subjects ANOVA revealed a main effect of landing area ($F(4)$ = 61.76, p < .001)
- An interaction between landing area and quartile was found ($F(12)$ = 38.99, p < .001)
- This interaction indicated that the distribution of saccade endpoints changed as a function of saccade latency
- Post Hoc analyses revealed that there were significantly more saccades ending on the target area than anywhere else (p < .001, *Figure 4A*)





- In the first two quartiles (*Figure 4B* and *4C*), the target, intermediate, and distractor areas were the most frequent saccade destinations, and no difference was observed between them
- However, these central landing areas differed significantly from the two peripheral landing areas. Pairwised comparisons between the peripheral and the central areas revealed a p < .005
- In the 3rd (*Figure 4D*) and 4th (*Figure 4E*) quartiles, the distribution of saccade endpoints was centred around the target area. Pairwised comparisons between the target and the remaining landing areas resulted in a p < .001



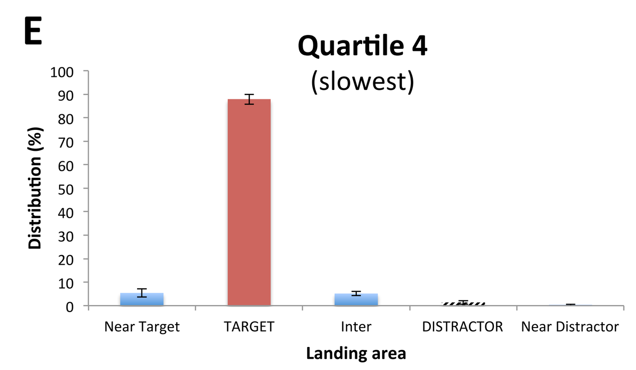


Figure 4: Distribution of saccade endpoints around the target and onset distractor in the 30° separation condition as a function of saccade latency quartile.

4 Results (beyond replication)

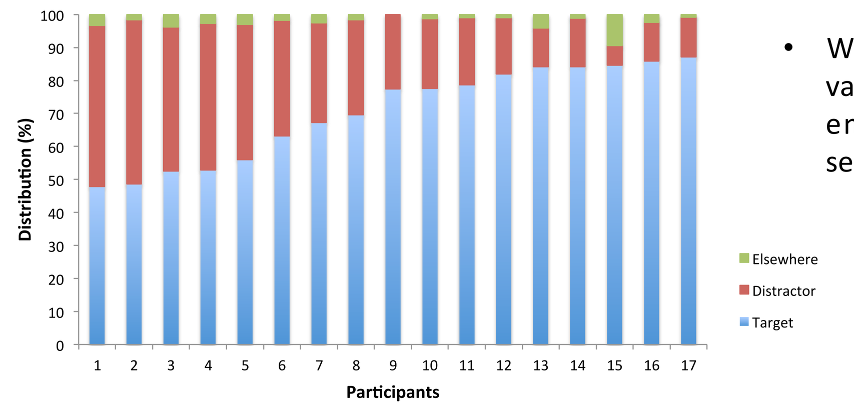


Figure 5: Individual distribution of saccade endpoints in the 90° and 150° separation conditions.

- We observed an inter-individual variability in the distribution of saccade endpoints in the 90° and 150° separation conditions

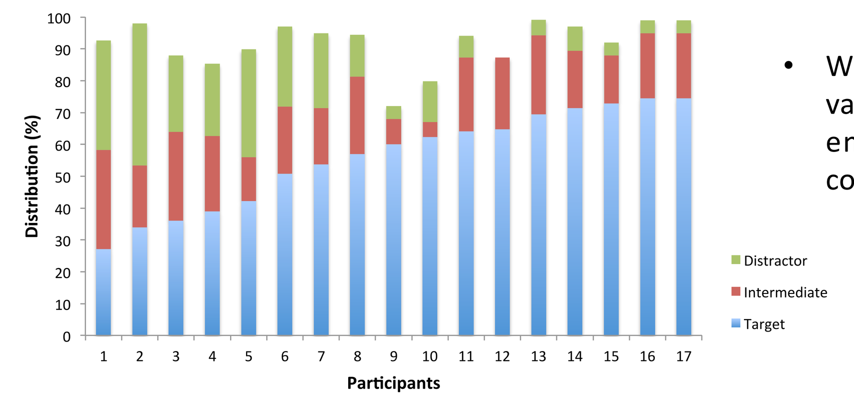


Figure 6: Individual distribution of saccade endpoints in the 30° separation condition.

- We also noticed an inter-individual variability in the distribution of saccade endpoints in the 30° separation condition

5 Discussion and conclusion

- Our results on saccade destinations and latencies were in agreement with those of Godijn & Theeuwes (2002)
- An intra-individual variability was assessed in that 25% of initial saccades were directed to the onset distractor, whereas the remaining ended on the target
- In the 30° separation condition, the large number of short-latency saccades on the target, intermediate, and distractor areas suggest a global effect
- Initial saccade latencies were shorter in the 30° and 90° conditions than in the no-onset condition, which suggests an effect of the onset distractor on saccade latency
- To complete the replication of the study of Godijn & Theeuwes (2002), we will assess the (a) trajectories of saccades to the target, and (b) saccade amplitude and fixation duration
- Further work will investigate the possibility to identify different individual profiles based on the oculomotor parameters obtained in the present study

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