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Influence of eye dominance on oculomotor and attentional selection

Introduction

► Eye dominance influences Perception and Action

The dominant eye (DE) is the one chosen to perform a monocular task. Neuroimaging studies have shown that it is anatomically and functionally linked to the ipsilateral V1 (Erdogan et al., 2002; Shima et al., 2010); the latter dealing with the contralateral visual hemifield due to the crossing of the optical pathways.

Using a global effect paradigm (Findlay, 1982; Walker et al., 1997), we have recently shown that the **DE-ipsilateral V1 relationship improves saccade accuracy in the hemifield contralateral to the DE**. Importantly, this contralateral advantage was found for participants with strong eye dominance only (Tagu et al., 2016).

► Aim of the current study

We tested whether the relationship between the DE and ipsilateral V1 led to higher saccade accuracy in the contralateral hemifield because of a **greater enhancement of the saccade target location**, or/and of a **more efficient inhibition of distractor locations** in this hemifield.

Participants had to perform a double task (saccade and visual discrimination). In conditions in which the saccade target (ST) and discrimination target (DT) spatially coincided, we investigated the **target location enhancement hypothesis**. In conditions in which the ST and DT did not spatially coincide, we investigated the **distractor locations inhibition hypothesis**.

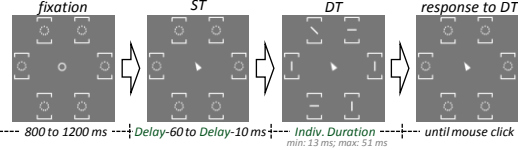
Methods

► Tasks & Procedure

After a **saccade training phase** and a **threshold estimation phase**, the participants performed 2 conditions:

► **Double-task**: Make a saccade at the cued location, and indicate whether the discrimination target (DT) is tilted clockwise or counterclockwise (with a left or right mouse click).

► **Discrimination-only task**: Remain on fixation and indicate whether the DT is titled clockwise or counterclockwise (with a left or right mouse click).



In both conditions the **DT appeared 50% of the time at the cued location, and 50% of the time at an uncued location** under a **variable Delay*** for a **Duration calculated individually** (i.e., DT duration for which participants reach 85% of correct responses in ST = DT trials of the discrimination-only task (weighted up-down method, Kaernbach, 1991)

*Delay = Latency (as estimated during a training phase) - Threshold duration

► Quantifying eye dominance strength

Eye dominance (left vs. right) was measured with the hole-in-card test (Miles, 1930). Eye dominance strength (strong vs. weak) was quantified by analyzing binocular saccadic peak velocity traces (Vergilino-Perez et al., 2012; Tagu et al., 2018):

- **Weak eye dominance** corresponded to higher peak velocity for leftward saccades of the left eye and for rightward saccades of the right eye (naso-temporal asymmetry).
- **Strong eye dominance** corresponded to higher peak velocity for a given saccade direction (leftward or rightward) with both eyes.

► Participants

3 strong right ED 9 strong left ED ⇒ **12 Strong eye dominance**
7 weak right ED 0 weak left ED ⇒ **7 Weak eye dominance**

► Instruments

- Binocular recordings with an EyeLink 1000 (SR Research®) sampled at 500 Hz
- BenQ XL2540 monitor (refresh rate: 144 Hz, resolution: 1920 x 1080 px)

► Stimuli

Dimension: 0.7°x1.2°, Eccentricity from fixation: 5.8°

Preliminary Results

► ST = DT trials: Enhancement of the ST location in the VF contralateral to the DE?

• ANOVA in a 2 (task: double-task, discrimination-only task) x 2 (DT visual field [VF]: ipsilateral to the DE, contralateral to the DE) x 3 (cue direction: up, horizontal, down) design. **Eye dominance strength as a between-subject factor.**

• ST-location enhancement hypotheses and results:

► Participants with strong eye dominance (ED) should show higher performance in the contralateral than in the ipsilateral VF.

⇒ **Not found.** But for weak ED, performance is higher in the ipsilateral (81±12%) than in the contralateral (75±12%) VF, p<.009. *Note that as all weak ED people have a right DE, their performance is higher in the right than in the left VF*

► In the contralateral VF, participants with strong ED should show higher performance when making a saccade than when remaining on fixation.

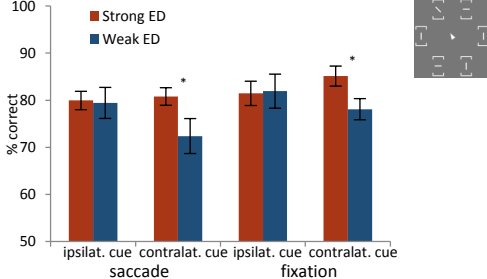
⇒ **Not found.** In reverse, all participants show higher performance when fixating (81±11%) than when making a saccade (76±12%), p<.03.

► In the contralateral VF, higher performance for strong ED than weak ED people.

⇒ **Found.** See figures below

• **Higher performance for horizontal** (88±9%) than up (72±13%) and down (75±13%) cues, p<.0002.

► ST = DT trials - all the cues



Summary

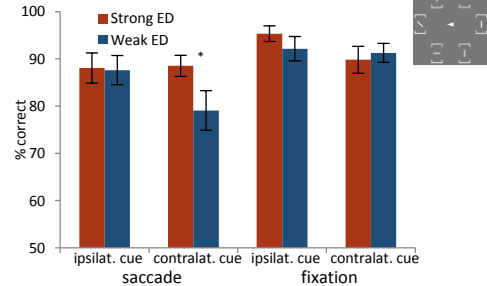
ST = DT trials

- In the VF contralateral to the DE, higher performance for strong than for weak ED.
- For participants with weak ED, higher performance for DT in the right than in the left VF.

ST ≠ DT trials

- Participants with strong ED show higher performance for contralateral than for ipsilateral DT.
- In the fixation-task, strong ED participants show higher performance when DT is in the uncued VF.

► ST = DT trials - horizontal cues



► ST ≠ DT trials: Inhibition of distractor locations in the VF contralateral to the DE?

• ANOVA in a 2 (task: double-task, discrimination-only task) x 2 (cued VF: ipsilateral to the DE, contralateral to the DE) x 2 (ST-DT distance: 60°, 120°) x 2 (DT location: in ST VF, not in ST VF) design. **Eye dominance strength as a between-subject factor.**

• Distractor-locations inhibition hypotheses and results:

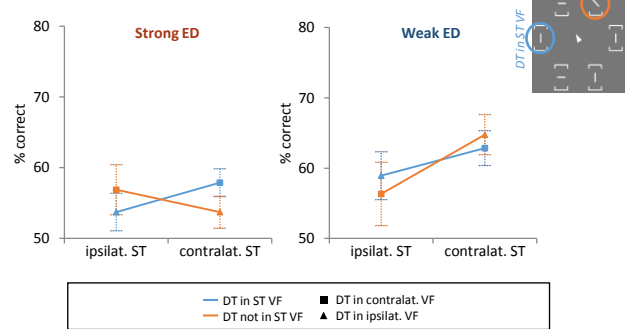
► Participants with strong ED should show lower performance when ST and DT both appear in the contralateral hemifield (but do not spatially coincide) than when the ST is in the contralateral VF and DT in the ipsilateral VF.

⇒ **Not found.** But strong-ED participants show higher performance when the DT is in the contralateral (57±14%) than ipsilateral (54±10%) VF (whatever the ST VF, see figures), p<.09.

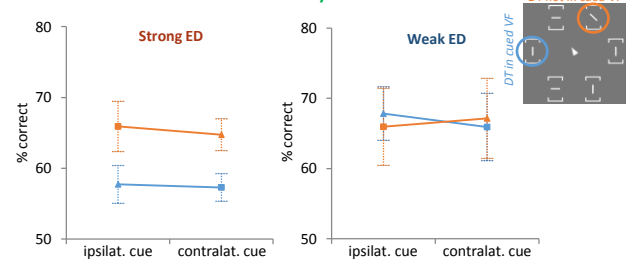
► Participants with weak ED should not show any asymmetry between the two visual fields.

⇒ **Not found.** They instead show higher performance when the cued VF is contralateral (60±9%) than ipsilateral (56±12%) to their DE, p<.03.

► ST ≠ DT trials - Double-task



► ST ≠ DT trials - discrimination-only task



Discussion

► Tendency for the ST-location enhancement rather than the distractor-locations inhibition hypothesis :

Results suggest that higher saccade accuracy in the hemifield contralateral to the DE found by Tagu et al. (2016) is due to target-location enhancement rather than distractor-locations inhibition.

► Eye dominance influences more perceptual than motor performance

Participants with strong ED consistently show higher performance for DT in the contralateral VF, whatever the ST location. This suggests perceptual rather than motor enhancement in this VF.

► Results in weak ED participants show the left hemisphere specialization for analytic processing of visual information

The fact that weak ED participants consistently show higher discrimination performance in the right than left VF could be due to the local/global specialization of the left/right cerebral hemispheres, respectively. This result should be strengthened by analysis of participants with weak left ED.