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► To cite this version:

Jérôme Tagu, Karine Doré-Mazars, Christelle Lemoine-Lardennois, Dorine Vergilino-Perez. A perceptual asymmetry may be determined by eye dominance. 18th European Conference on Eye Movements, Aug 2015, Vienna, Austria. , Journal of Eye Movement Research, 8 (4), pp.179, 2015, 10.16910/jemr.8.4.1. hal-01488463

HAL Id: hal-01488463 https://hal.science/hal-01488463

Submitted on 13 Mar 2017 $\,$

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A perceptual asymmetry may be determined by eye dominance

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Introduction The dominant eye is the one used to sight in a camera. Neuroimaging studies have shown that dominant eye is preferentially linked to the ipsilateral primary visual cortex (Erdogan et al., 2002 ; Shima et al., 2010), that deals with the contralateral visual field due to optical pathways' crossing. Recently, Vergilino-Perez et al. (2012) showed with binocular recordings of eye movements that participants could exhibit a weak or strong eye dominance.

•Strong eye dominance : saccades exhibit faster peak velocity toward the dominant eye's ipsilateral visual field (ipsiVF), irrespective of the eye being recorded.

•Weak eye dominance : saccades exhibit faster peak velocity toward the left visual field (LVF) with the left eye and faster peak velocity toward the right visual field (RVF) with the right eye, such a pattern was previously described as a naso-temporal asymmetry (Robinson, 1964).

Recently, Chaumillon et al. (2014, 2015) showed a better perceptual processing in the hemifield controlateral to the dominant eye (controVF) in participants with a strong eye dominance, indexed by a faster target detection and a greater saccade deviation in the controVF. This was not the case for participants with a weak eye dominance.

Methods

Participants:

92 right-handed participants (73 $\stackrel{\circ}{_{\rm +}}$, 22.3 ± 5 y.o.) divided into 4 groups according to their eye dominance (« Hole-in-the-card test », Miles, 1930) and the strength of their eye dominance (pattern of peak velocity, Vergilino-Perez et al., 2012):

- 22 R+ (right and strong eye dominance)
- 35 R- (right and weak eye dominance)
- 10 L+ (left and strong eye dominance) 25 L- (left and weak eye dominance)

Stimuli:

•Central fixation cross: 0.5 x 0.5° white cross, luminance of 4.5 cd/m² Saccade target : 0.5 x 0.5° white circle, luminance of 27 cd/m² Distractor: 0.5 x 0.5° white circles, luminance of 27 cd/m² or 54 cd/m²

Medium gray background, luminance of 4.5 cd/m².

Results

Global effect:

If global effect percentage (GEP) = 0% → saccade lands on the distractor (maximum global effect) If GEP = 100% → saccade lands on the target (no global effect)

Hypotheses:

For participants with a strong eye dominance (R+ or L+) :

=> a smaller GEP (i.e., a greater global effect) in the controVF than in the ipsiVF = a greater global effect in the left visual field (LVF) for R+ and in the right visual field (RVF) for L+.

This effect was not expected for participants with a weak eye dominance.

Results:

•Effect of hemifield (F(1,88)=7.73, p<.01): Smaller GEP (greater global effect) in LVF (69.14%) than in RVF (71.59%).

•Interaction with eye dominance (left or right) and its strength (strong or weak) (F(1,88)=8.86, p<.005, see figures):

For L+: More effect of distractor on saccade amplitude in LVF (ipsiVF, GEP=62.43%) than in RVF (controVF, GEP=75.39%) (F(1,9)=11.92, p<.01). For R+: More effect of distractor on saccade amplitude in RVF (ipsiVF) than in LVF (controVF) but marginally significant (F(1,21)=2.92, p<.10). For L- and R-: Difference of global effect between hemifields also marginally significant (F(1,58)=2.98, p<.10), the GEP tends to be smaller in LVF (69.72%) than in RVF (72.52%) (reflecting a greater global effect in LVF).

Remote distractor effect:

Hypotheses: The remote distractor would have more effect on saccade latency when presented controlaterally to the dominant eye than when presented ipsilaterally for participants with a strong eye dominance.

Our results indicate no effect of hemifield, eye dominance or its strength, neither any interaction of these factors.

Conclusion

Our results on global effect showed that for participants with a strong eye dominance, the saccade was more accurate in the hemifield controlateral to the dominant eye, suggesting that when we saccade to a target, the relationship between dominant eye and ipsilateral primary visual cortex does not involve a greater perceptual effect of the distractor, but rather a greater saccadic selection of the target in this hemifield. However, this seems to be attenuated for participants with a strong right eye dominance.

To explain these differences between participants with a strong left and right eye dominance, we propose that 2 phenomena are involved :

- A saccade target selection more accurate in the hemifield controlateral to the dominant eye in participants with a strong eye dominance.
- An attentional bias to the left visual field giving more weight to the distractor due to the specialization of the right hemisphere for visuo-spatial attention.

For participants L+ , those 2 phenomena occur in different hemifields, leading to an amplification of the difference of global effect between the 2 visual fields.

Conversely, for participants R+ those 2 phenomena occur in the same hemifield, and the attentional bias counteracts with the saccadic selection, leading to a reduction of the difference of global effect between the 2 visual fields.



Does the link between dominant eye and ipsilateral primary visual cortex induce a better perceptual processing in the controVF compared to the ipsiVF when participants have to make a saccade toward the hemifield ?

92 right-handed participants were submitted to global and remote distractor effect situations (Walker et al., 1997).

A greater effect of the distractor presented controlaterally to the dominant eye was expected on saccadic amplitude (global effect) and latency (remote distractor effect) only for participants with a strong eye dominance.

No difference on saccadic parameters was expected between the two visual fields in the case of a weak eye dominance.

Instruments:

Binocular recording with an EyeLink 1000 system, SR Research®, sampled at 500 Hz and 0.25°. Stimuli were displayed on a liyama HM240DT monitor (170 Hz refresh rate, 800 x 600 pixels resolution).

Procedure:

 4 blocks of 165 trials (total of 660 trials) ; 2 blocks with saccade target presented in the left hemifield, 2 blocks within the right hemifield. The order was counterbalanced across subjects with alternating the target side.

 Each trial began by the presentation of the initial fixation cross randomly displayed during 500. 600, 700 or 800 ms. The initial fixation cross disappeared at the time the target appeared (step).

•In the control no-distractor conditions, the isolated target was presented 3°, 5° or 7° to left or right of the fixation cross on the horizontal axis.

•In the target-distractor conditions, the target was presented at an eccentricity of 5° or 7° to left or right of the fixation cross with a distractor presented at an eccentricity of 3° in the same hemifield (testing the global effect) or in the opposite (testing the remote distractor effect).



For Weak Eye Dominance



