Background

Amblyopia is characterized by interocular asynchrony which manifests as an interocular delay affecting either the amblyopic or the fellow eye (1, 2) (3).

Current methods for measuring this delay are typically only effective for either mild (1, 2) or strong (3) amblyopes, but not both (4).

A recent paradigm developed by Burge and Cormack (2020) (5) may have the capacity to alleviate this limitation (6). This method utilizes continuous psychophysics, and because it can be performed monocularly, it does not require binocular fusion or stereopsis.

In the current study, we assess the applicability of this paradigm to amblyopia research and investigate the relationship between interocular delay and visual acuity.

Methods

Stimuli and procedure

Tracking paradigm adapted from Burge and Cormack (2020)

In each 11 second trial, the stimulus (Figure 1) underwent lateral Brownian motion.

Participants tracked the stimulus as accurately as possible with the mouse cursor.

Nine blocks of 40 trials were performed; each block had a unique combination of viewing and contrast conditions.

Participants

23 amblyopes and 14 controls

The Porta Test was used to determine the dominant eye of control subjects.

Results

Calculating Latency

Figure 2: a) Raw data from tracking task. The position of the stimulus (black line) and the mouse (red line) are plotted as a function of time. b) Crosscorrelation between stimulus and mouse data as a function of lag. The lag at which the correlation is strongest indicates the temporal offset between the stimulus and mouse.

Latency Across Participants

Figure 3: Average within subject latencies between stimulus and mouse in each condition for both controls (a) and amblyopes (b). Black lines and black + symbols mark the median and mean respectively. Box edges and whiskers indicate the quartiles and the range respectively. * p<0.05 Wilcoxon signed rank test.

Interocular Delay

Figure 4: Difference in latency between the AE/NDE and binocular plotted against the difference in latency between the FE/DE and binocular for controls (a) and amblyopes (b). Points represent individual participants. Significantly different latencies between the two eye (p < 0.05 Wilcoxon signed rank test) are indicated with a star symbol. In (b), lager point size indicates larger interocular visual acuity difference. Participants plotted further from the dashed reference line display larger interocular delay.

Conclusions

Interocular delay can be accurately measured using continuous psychophysics.

Amblyopes are confirmed to exhibit an interocular delay the exact pattern of which varies from person to person.

Tracking accuracy tends to be worse when relying on the amblyopic eye.

Interocular delay tends to be positively correlated with interocular visual acuity difference.

Relationship Between Interocular Delay and Acuity

Figure 5: Average within subject correlation coefficients in each condition. Black lines and black + symbols indicate the median and mean respectively. Higher coefficients indicate better tracking performance. * p<0.05 Wilcoxon signed rank test.

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References