Variability in smooth pursuit initiation is rather driven by the motor output

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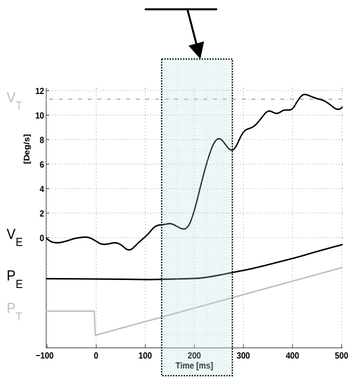
Introduction

Smooth pursuit is variable across trials, especially for the initiation (open-loop) phase.



Where resides the largest source for this variability? Kowler and McKee (1987) compared oculometric with psychometric functions and showed that the greatest source is in the motor output. In contrast, Osborne et al (2005) employed PCA and concluded that the greatest source resides in the sensory process. We tried to resolve this debate by applying both methods to the same data set.

Methods

Material: 3 subjects. Dual Purkinje eye tracker. 5 target speeds (random within session).

Task: Subjects did smooth pursuit and a psychophysical decision (faster/slower than standard) at the completion of a trial.

Results

Trace Fitting, Oculometric & Psychometric Functions

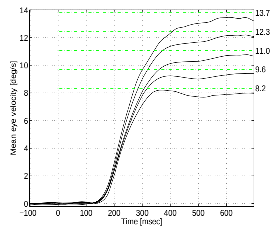


Fig 1 Average trace for each of the 5 speeds for one observer.

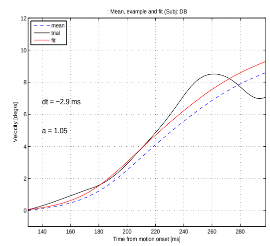


Fig 2 Example of how a single trial trace is fitted to the average trace to obtain its amplitude and latency parameter (Osborne et al 2005).

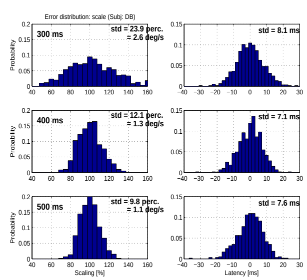


Fig 3 Example distributions of amplitudes and latencies for different analysis intervals.

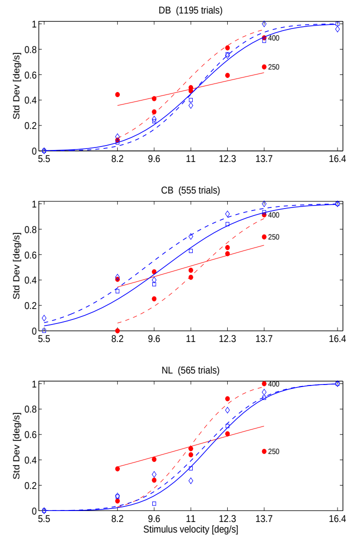


Fig 4 Oculometric functions (grey-scale) and psychometric functions (blue, magenta).

Oculometric functions: percentage of trials greater than mean per given analysis interval.

Psychometric functions: percentage of responses judged faster than standard.

Note: Psychometric functions are as steep as oculometric functions for large analysis intervals

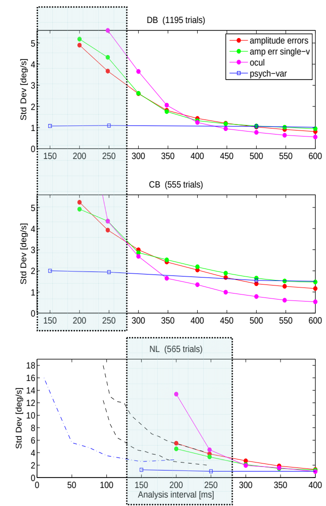


Fig 5 Variability (standard deviation) as a function of time as derived from oculometric (magenta) and psychometric (blue) functions

Note the large difference during initiation, e.g. at 200ms.

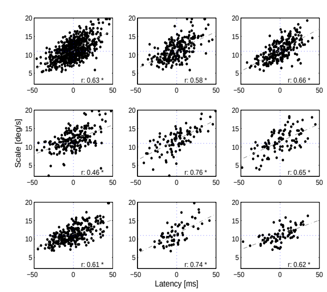


Fig 6 Latency-amplitude correlations. All are significant.

Results

PCA analysis

1. PCA assumes independence, but the latency-amplitude correlations in Figure 6 show strong dependence between variables.
2. The Eigenvectors did not look consistent across subjects (not shown).

Summary & Conclusion

1a. The oculometric and psychometric functions give consistent results across subjects, see Figures 4 and 5.

1b. Oculomotor variability is substantially higher than psychometric variability during initiation.

2. The PCA analysis did neither show consistent results across subjects, nor were they similar to the ones as presented in Osborne et al 2005.

Therefore, the large variability seen during smooth pursuit initiation is primarily caused by the motor output.

References

Kowler, E. and Mckee, S. (1987). Sensitivity of smooth eye movement to small differences in target velocity. Vision research. 27(6):993--1015.

Osborne, L., Lisberger, S., and Bialek, W. (2005). A sensory source for motor variation. Nature, 437(7057):412-416.

Acknowledgements

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