

The Great Binocular Bake Off: Comparing Methods for Measuring Interocular Delays



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APPLY LAB

Background

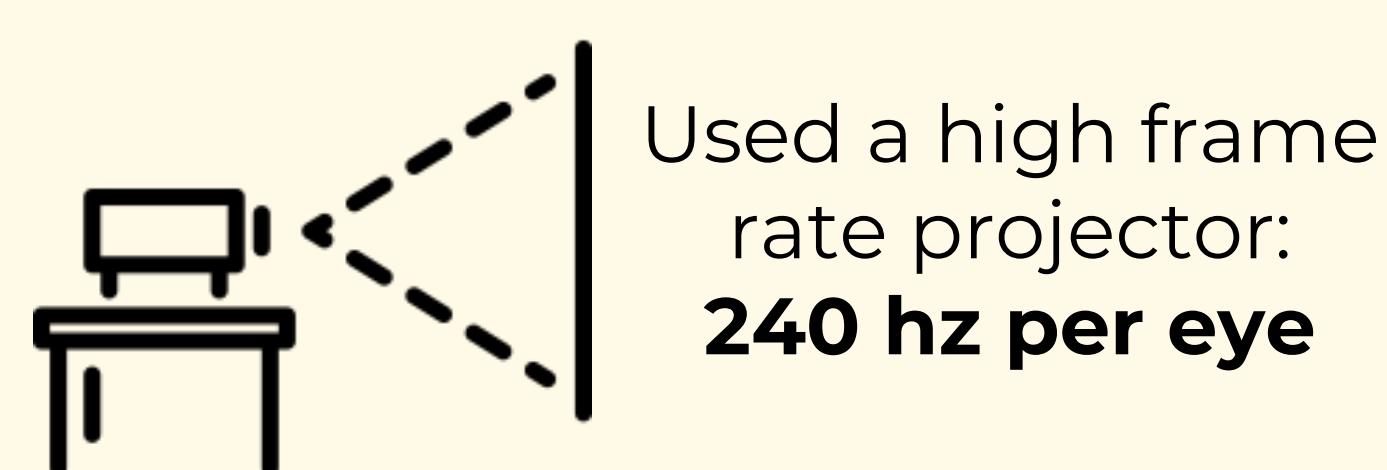
- Deficits in binocular disorders (amblyopia) are characterized by differences in spatial processing.
- However, previous work has shown deficits in temporal processing as well, including interocular delays.
- Many methods have been developed for measuring interocular delays, but they have not been systematically compared.

How consistent are methods that measure interocular delays:

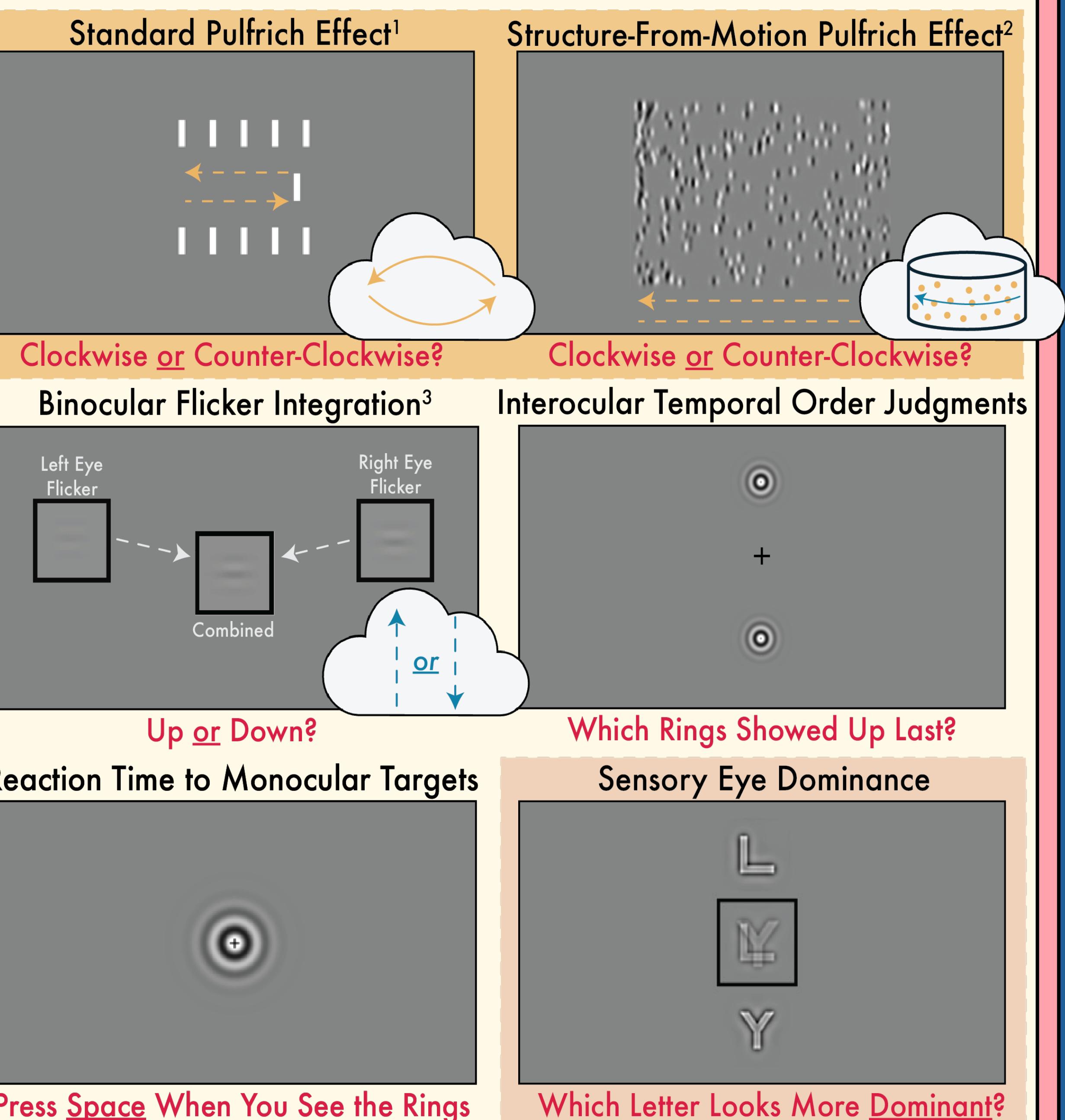
- (1) With variation in normally sighted observers?
- (2) With a filter-induced delay to one eye?

Methods

Normally sighted participants completed six tasks in a randomized order, wearing polarized 3D glasses

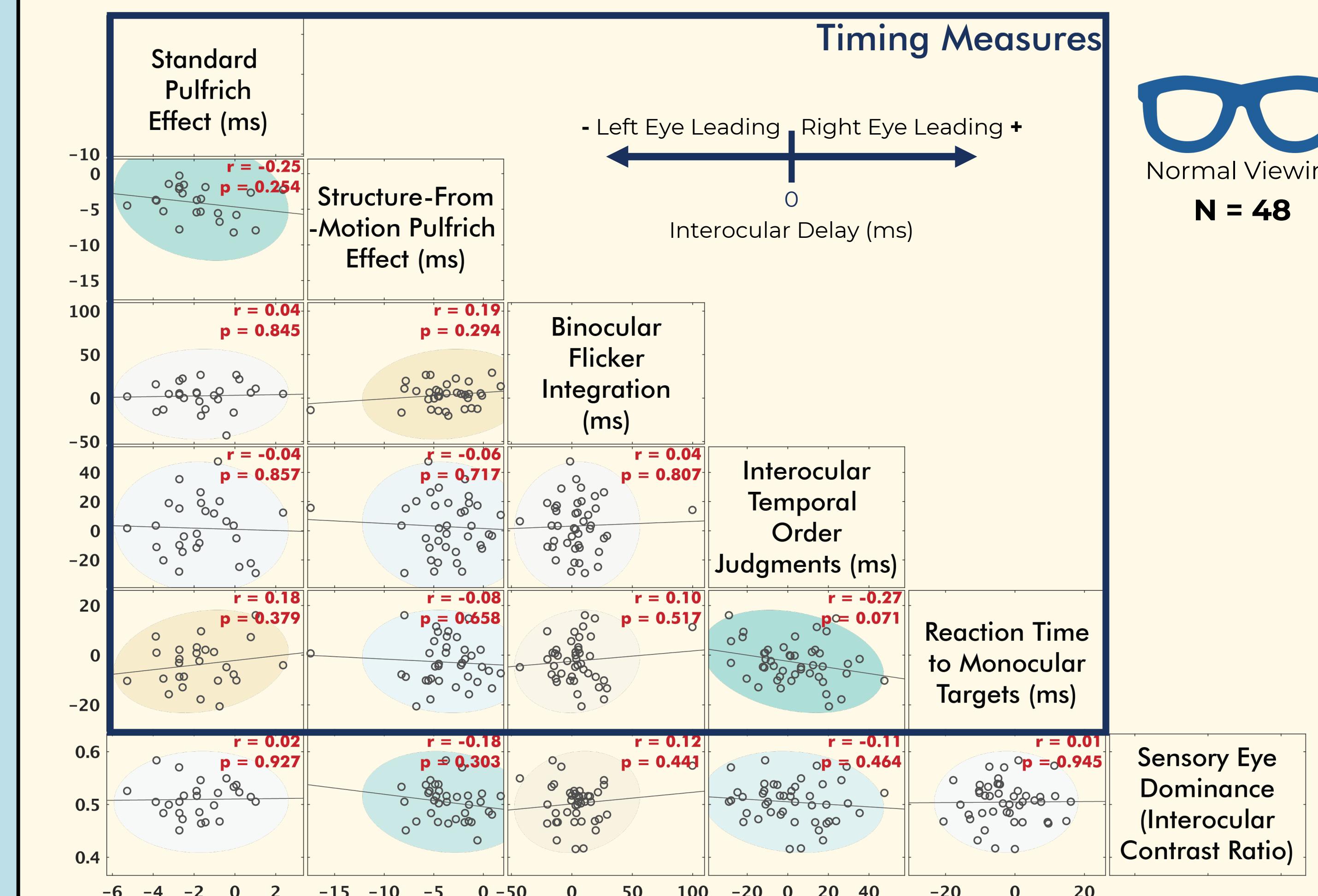


Depth-Based Judgments



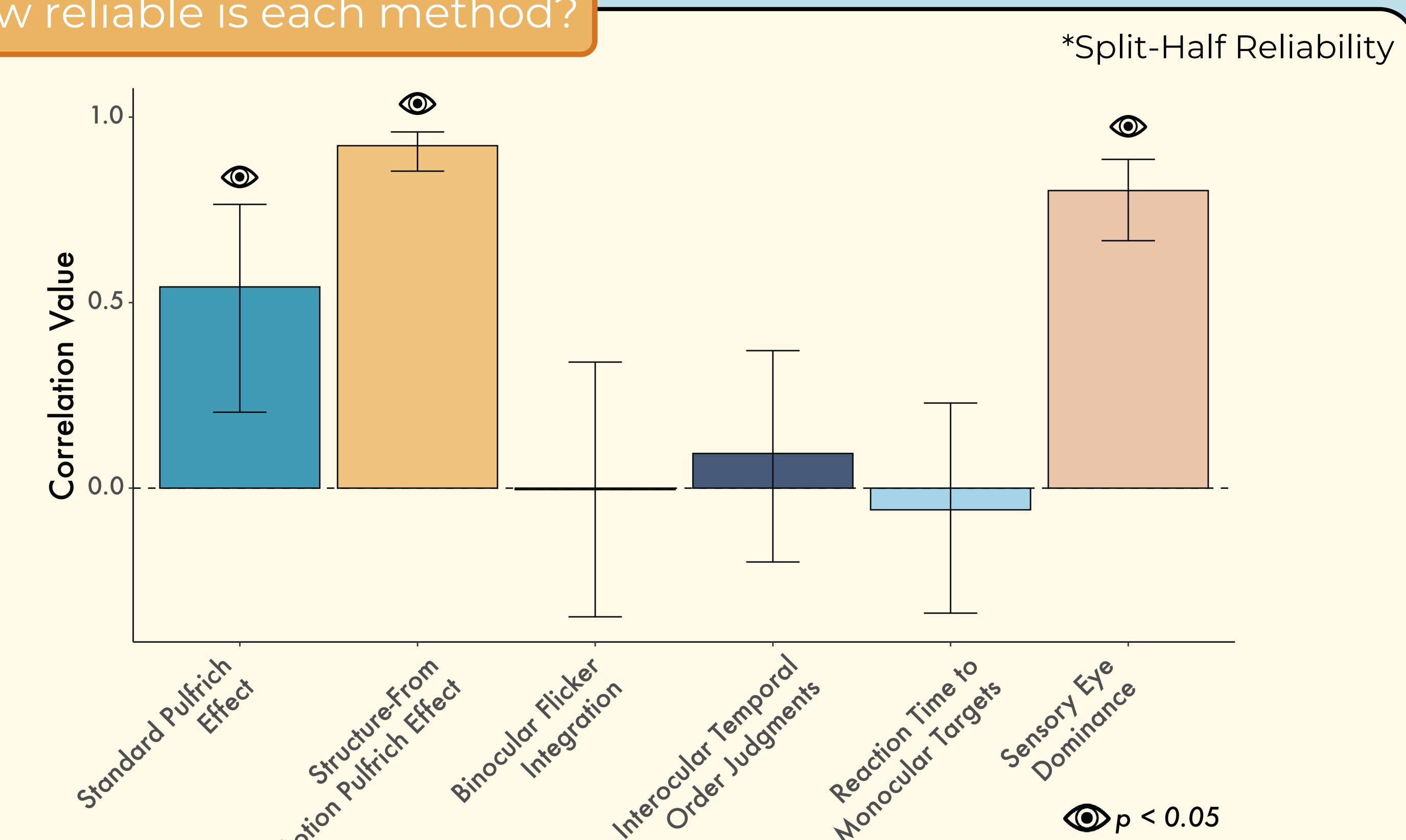
Exp 1: Individual Differences

How much agreement is there across methods?



Method agreement: Variation in normally sighted participants is not large enough to show any significant correlations across tasks

How reliable is each method?



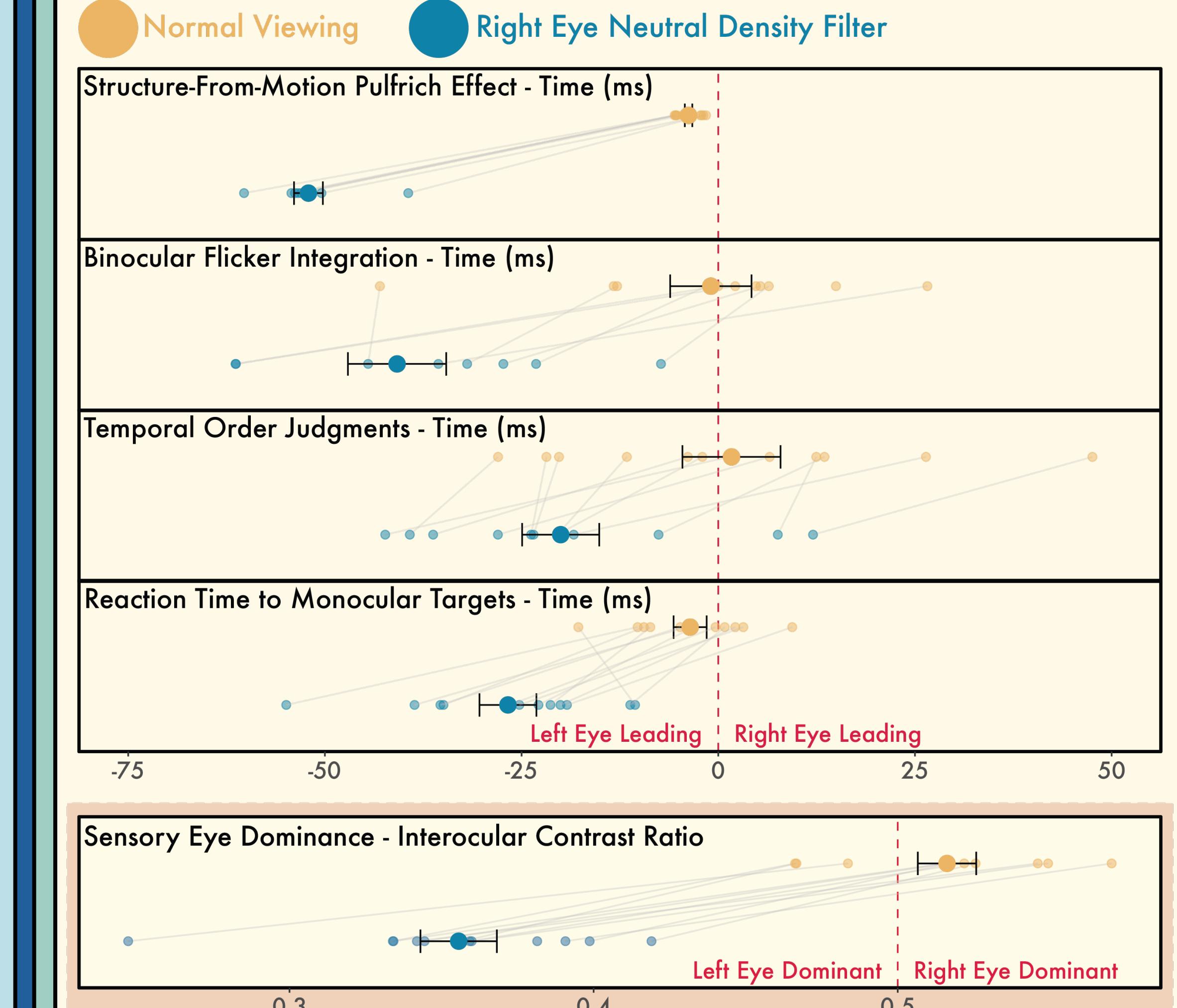
Method Reliability: Some tasks show better split-half reliability than others, but estimates are limited by the narrow range of the data

Conclusion: Exp 1

Even with good split-half reliability for some measures, there is not enough variation in interocular delays in normally sighted participants to show a correlation between tasks.

Exp 2: Effect of Neutral Density Filter

Can each method measure timing delays?



All $p < 0.05$

Measuring Delays: Applying a neutral density filter on the right eye significantly induced a right-eye delay in each method, but was too large to measure with the Standard Pulfrich effect

Do the methods agree with one another?

*Repeated Measures Correlation

Structure-From-Motion Pulfrich Effect	Binocular Flicker Integration	Interocular Temporal Order Judgments	Reaction Time to Monocular Targets	Sensory Eye Dominance					
$r = 0.915$ $p = 0.001$									
$r = 0.815$ $p = 0.014$	$r = 0.665$ $p = 0.036$								
$r = 0.770$ $p = 0.024$	$r = 0.601$ $p = 0.063$	$r = 0.656$ $p = 0.015$							
$r = 0.963$ $p < 0.001$	$r = 0.838$ $p = 0.002$	$r = 0.844$ $p < 0.001$	$r = 0.844$ $p < 0.001$						
				Correlation					
-1	-0.8	-0.6	-0.4	0	0.2	0.4	0.6	0.8	1

Method agreement: Nearly all methods are significantly correlated with each other, indicating good agreement in the delay produced by adding a darkening filter on the right eye

Conclusions: Exp 2

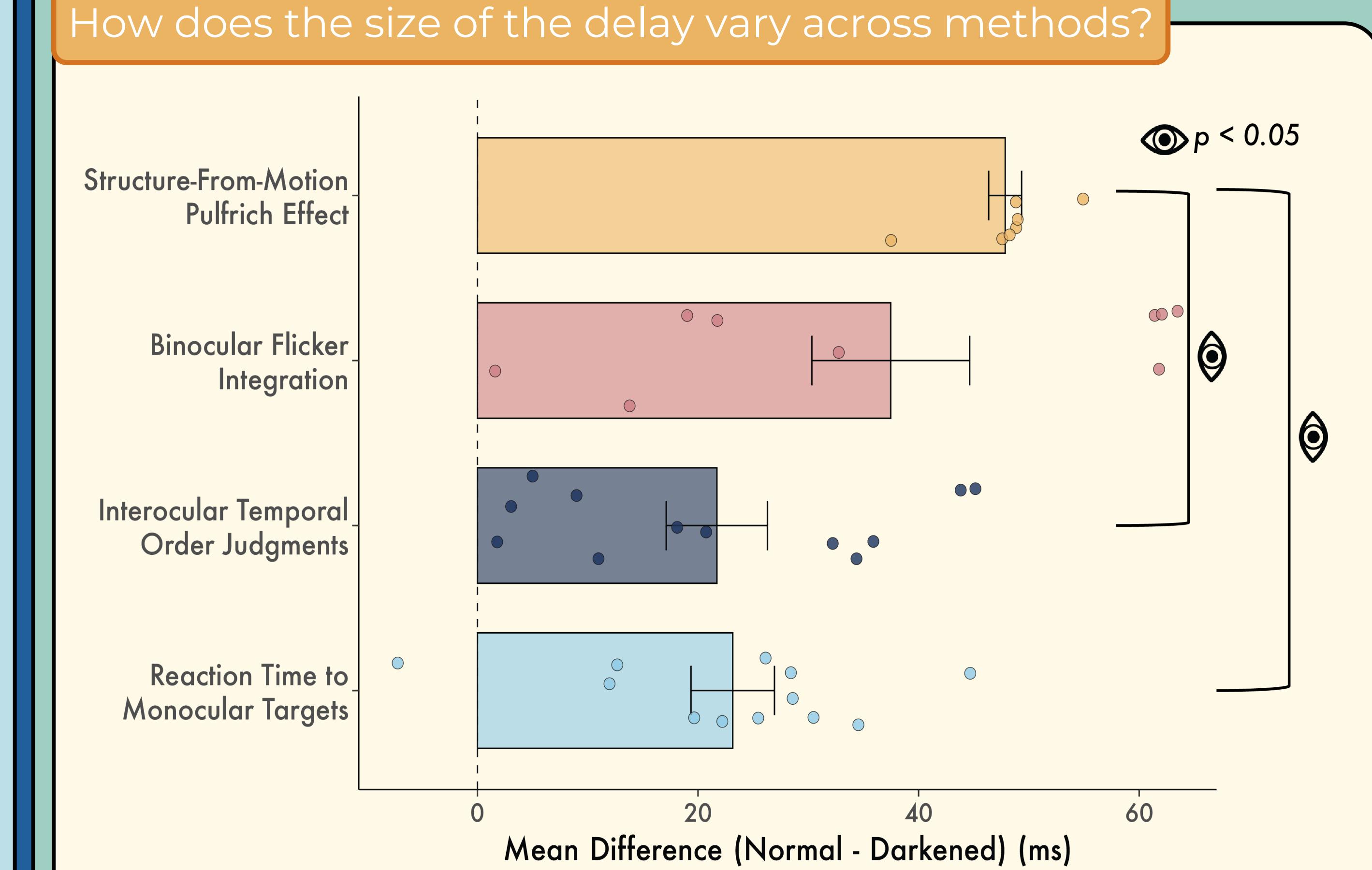
Methods show broad agreement in the effect of a darkening filter on the estimated delay, with some variability across tasks.

Participants are very sensitive to timing differences between the eyes when they produce changes in depth.

Other methods may be needed for participants who have limited stereopsis.

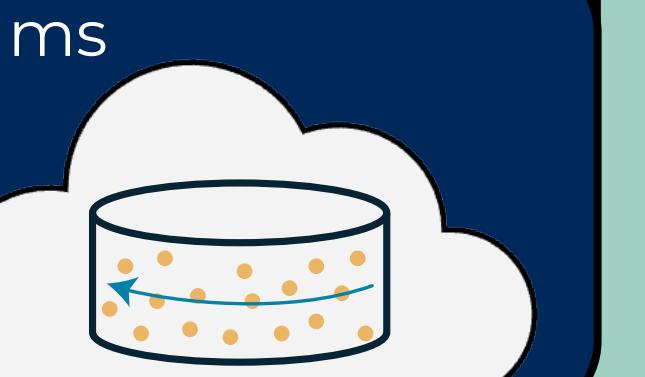
Overall Conclusion:

In normally sighted observers, there is not enough spread in the estimated delays to show consistency across methods. However, they each reliably measure a filter-induced delay.



Delay Variation: Across methods, estimates range from 22 to 48 ms

Effect Size: The Structure-from-Motion Pulfrich Effect produced the largest difference between conditions, and the smallest variability between subjects



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References: [1] Burge J, Rodriguez-Lopez V, Dorronsoro C. *Curr Biol*. (2019). [2] Min SH, Reynaud A, Hess RF. *Vision* (2020). [3] Shadlen M, Carney T. *Science*. (1986).