



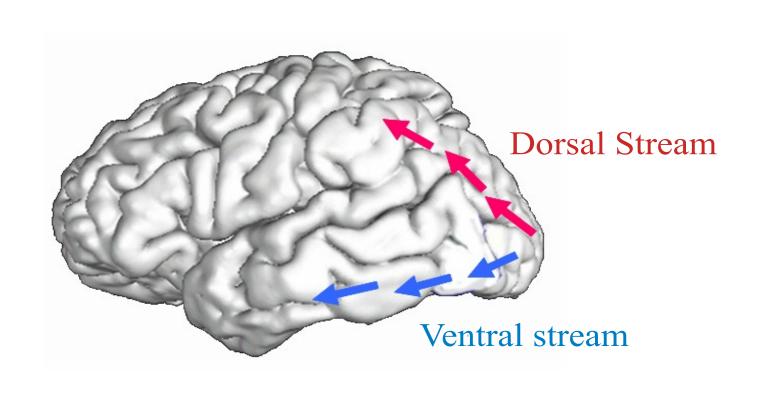
Differences in the Temporal Integration Limits of Stereovision in Perception and Action

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Introduction

Alternating monocular views can be integrated to achieve stereopsis even with interocular delays of up to 100ms. However, these studies have typically been done in the perceptual domain¹.



Research has demonstrated that separate cortical streams have developed in order to process vision-for-perception (ventral stream) and vision-for-action (dorsal stream)². The dorsal stream uses binocular information to form visuomotor representations that produce more efficient grasping³. Given the different task demands placed on these two streams, the question arises:

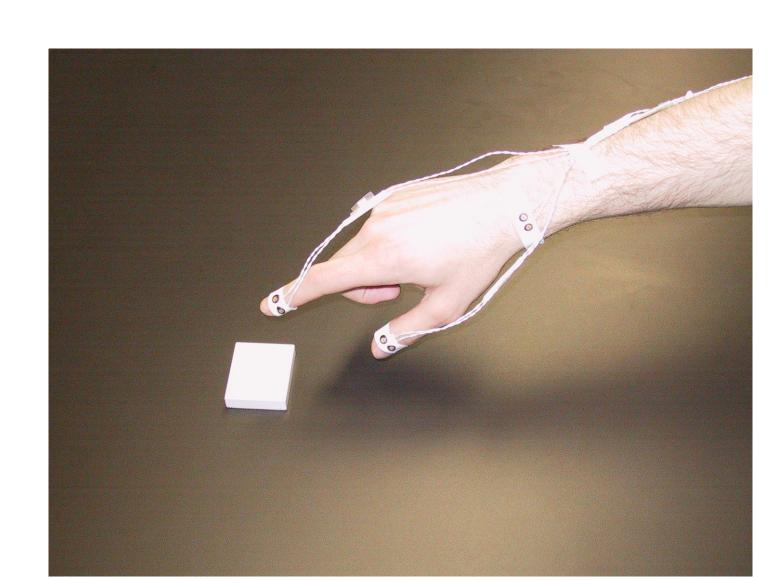
Are the 'action' and 'perception' streams equally tolerant to interocular delay?

Study 1

Participants

44 participants (29 females, 15 males, age range 18-31, mean = 20.7 years) were recruited from the University of Manitoba subject pool.

All participants were right-handed, had normal or corrected-to-normal vision, and had a minimum stereoacuity of 40° arcsec.



Measurement

Pairs of Infrared Emitting Diodes (IREDS) were attached to the thumb, index finger and wrist (above). 3d reaching and grasping data was acquired via an Optotrak Certus.

Experimental Design

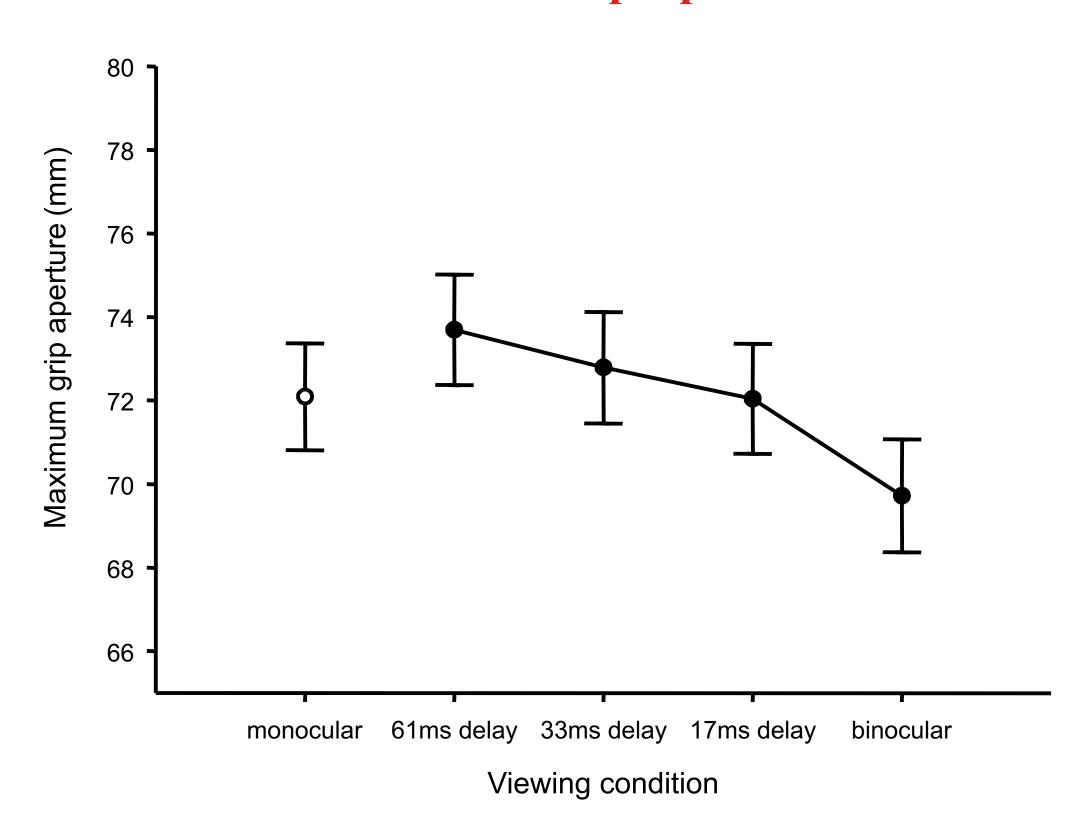
Participants reached out and picked up objects placed along their midline at distances of 25, 35 or 45 cm.

Monocular, binocular, or alternating monocular viewing conditions were produced with the aid of LCD goggles.

The presented data are from the 35 cm distance; the other two distances were used as distractors.

Results

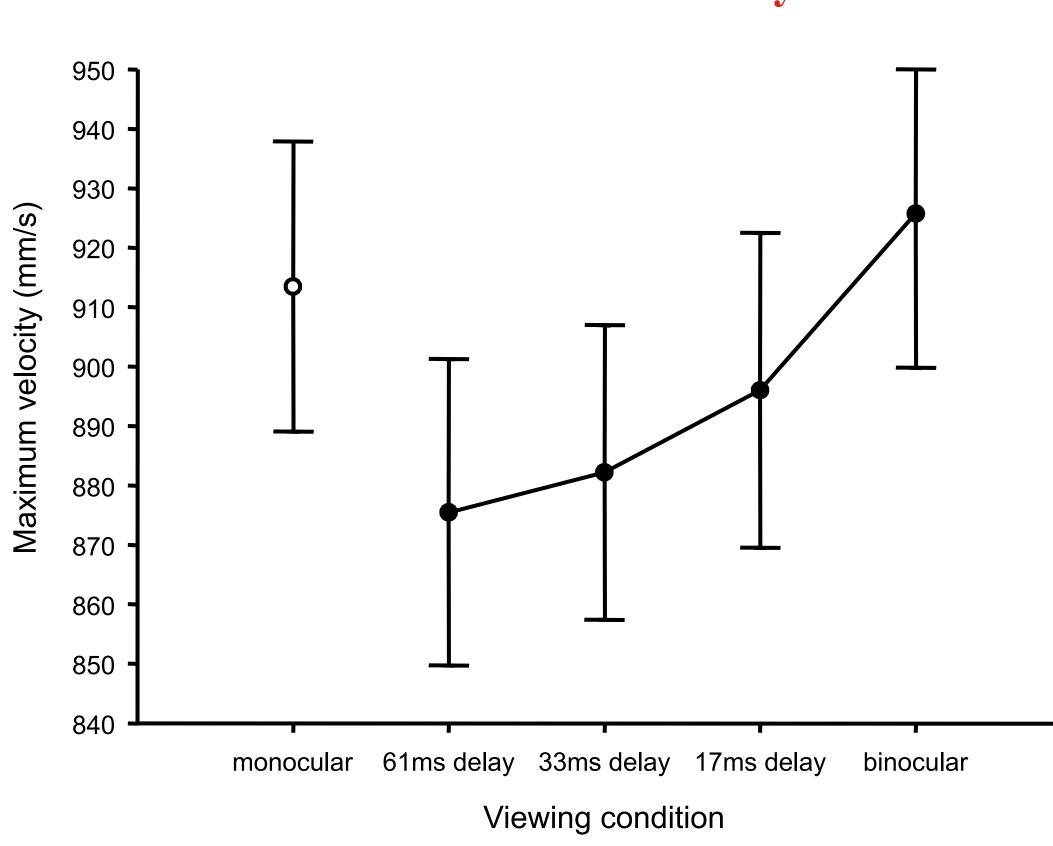
Maximum Grip Aperture



Participants were most efficient under binocular viewing conditions, producing smaller grip apertures (see above) than all other conditions (p<.005), and faster peak velocities (see below) than in the alternating monocular conditions (p<.06).

In the longest delay condition (61 ms), both maximum grip aperture and maximum limb velocity were worse than in the non-alternating monocular condition (p<.05).

Maximum Limb Velocity



Study 2

Purpose

To establish the limits of interocular delay that could be tolerated before the breakdown of stereopsis under conditions analogous to those of the reaching and grasping task.

Participants

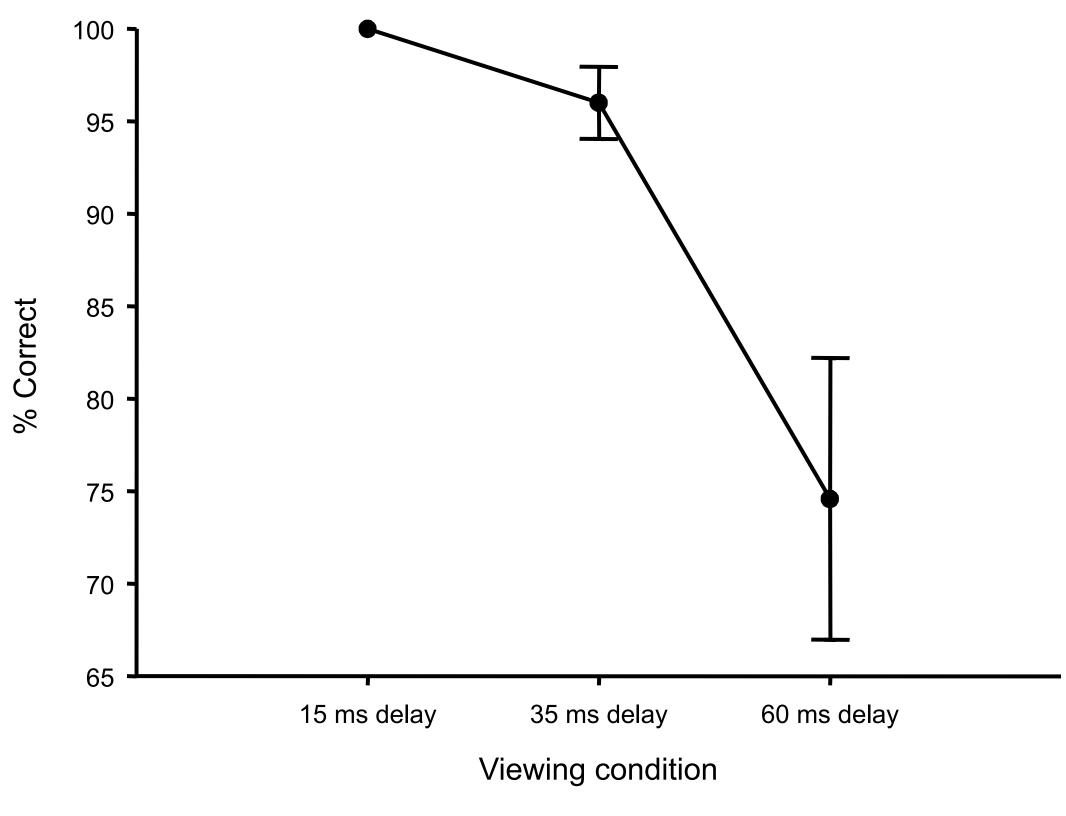
7 Participants (5 females, 2 males, age range 21-59, mean = 29.0 years) were recruited from the University of Western Ontario. All had normal or corrected-to-normal vision

Experimental Design

Participants viewed a computer-generated random-dot display through ferroelectric shutter goggles. The stereo half images were presented for 50 ms alternately to each eye with an inter-ocular delay of 15, 35 or 60 ms. Using a single-interval forced choice procedure, participants were required to indicate whether they saw the target image in front or behind the plane of the screen.

Results

Mean Accuracy



Accuracy was unaffected by the 15 ms delay condition (100% correct) or by the 35ms delay condition (96% correct).

An interocular delay of 60 ms did impair accuracy (75% correct, p<.05), however, performance was still well above chance levels.

Study 3

Purpose

The differential findings in Study 1 and Study 2 could be due to one of two factors: (1) a fundamental difference in how the 'perception' and 'action' streams deal with stereo information, or (2) the fact that the visuomotor task in Study 1 is dynamic in nature, where as the perceptual task in Study 2 is static.

Study 3 was designed to explicitly test this second hypothesis.

Participants

40 participants (30 females, 10 males, age range 19-46, mean = 24.8 years) were recruited from the University of Manitoba subject pool.

Experimental Design

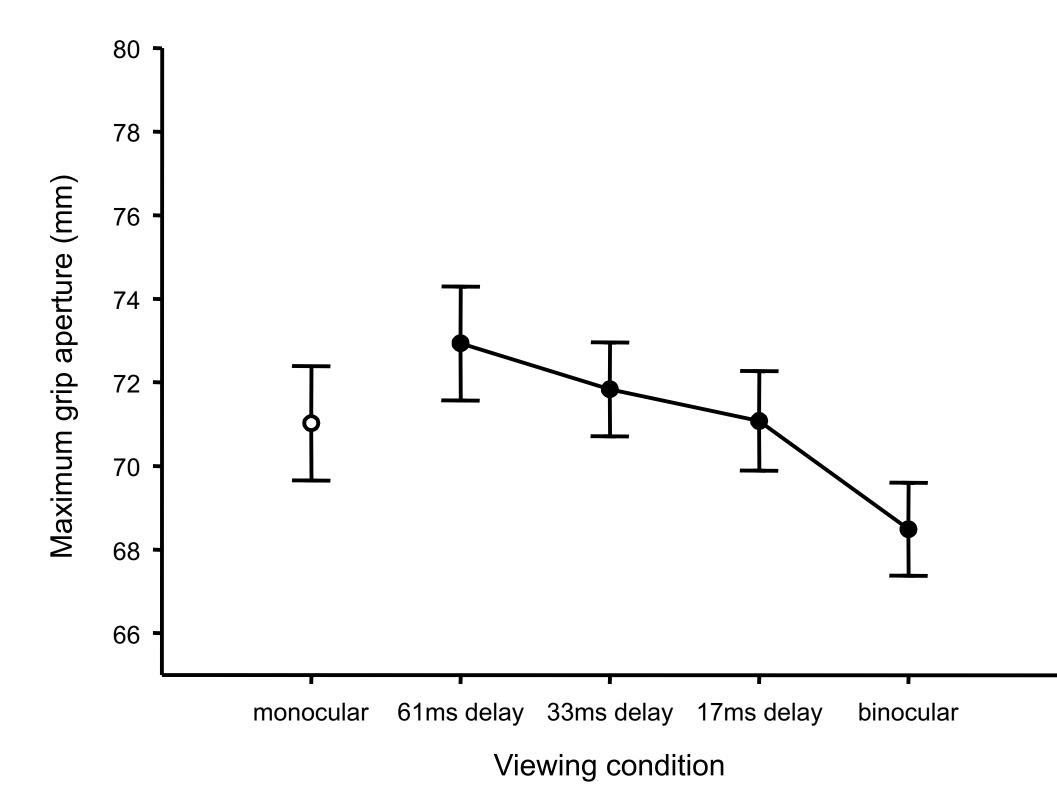
Half of the participants completed a modified version of Study 1, in which a chin rest was used to maintain the viewing position.

An apparatus was used to prevent the remaining participants from viewing their hand until it was within a few centimeters of the nearest object.

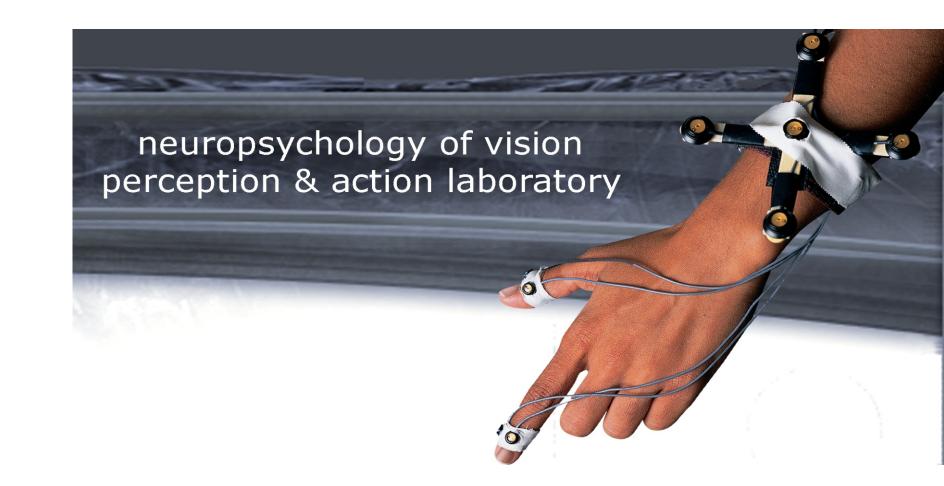
As in Study 1, the presented data are from the 35 cm distance.

Results

Maximum Grip Aperture

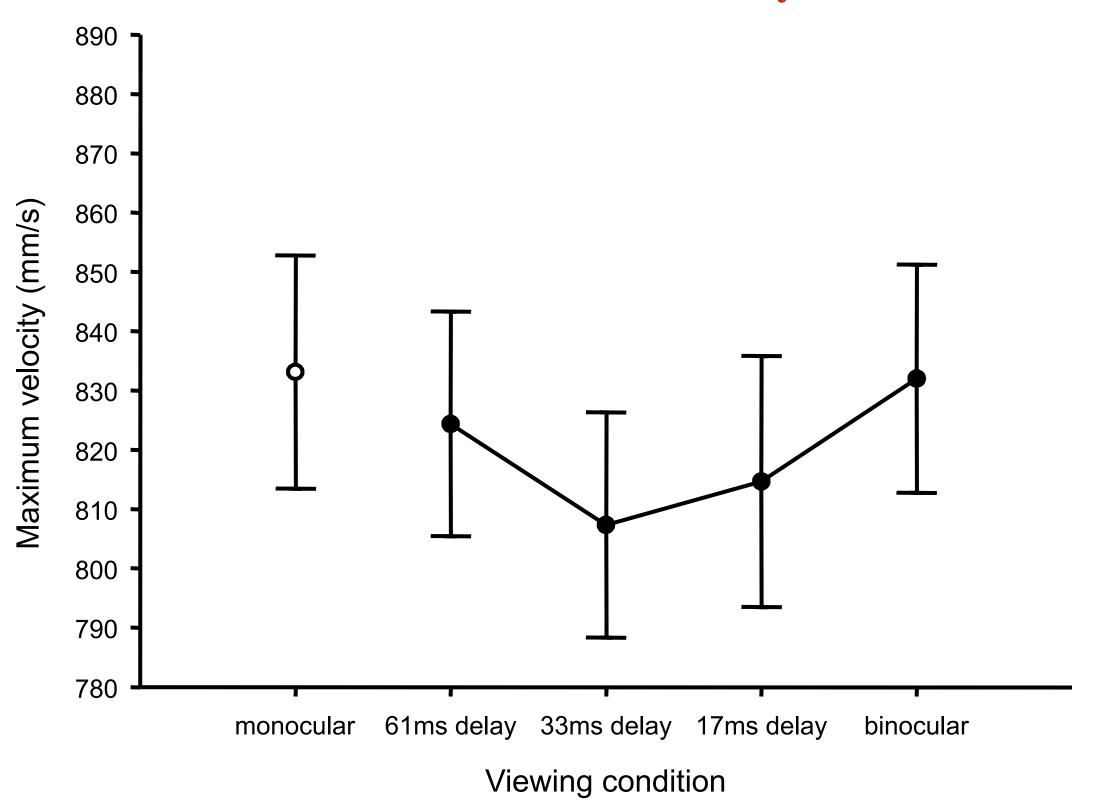


The data from Study 3 replicate the findings in Study 1. Moreover there were no differences between the occluded and non-occluded groups (p>.05), suggesting that the dynamic/static nature of the tasks cannot account for the different tolerances to interocular delay in Studies 1 and 2.



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Maximum Limb Velocity



Conclusions

Our results show that even the smallest interocular delay impairs reach performance. In contrast, performance on the perceptual task was not significantly affected until there was a 60 ms interocular delay.

These results suggest that the temporal limits of stereopsis in the perceptual system are more robust than those of the visuomotor system.

In fact, our current data and those provided by Bennett et al.⁴ suggest that visually guided action may have very little or no tolerance to interocular delay. It may be that there is no acceptable delay for the visuomotor system and all depth information has to be calculated moment-to-moment.

References

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