Timing relationships between actions and sound in music performance

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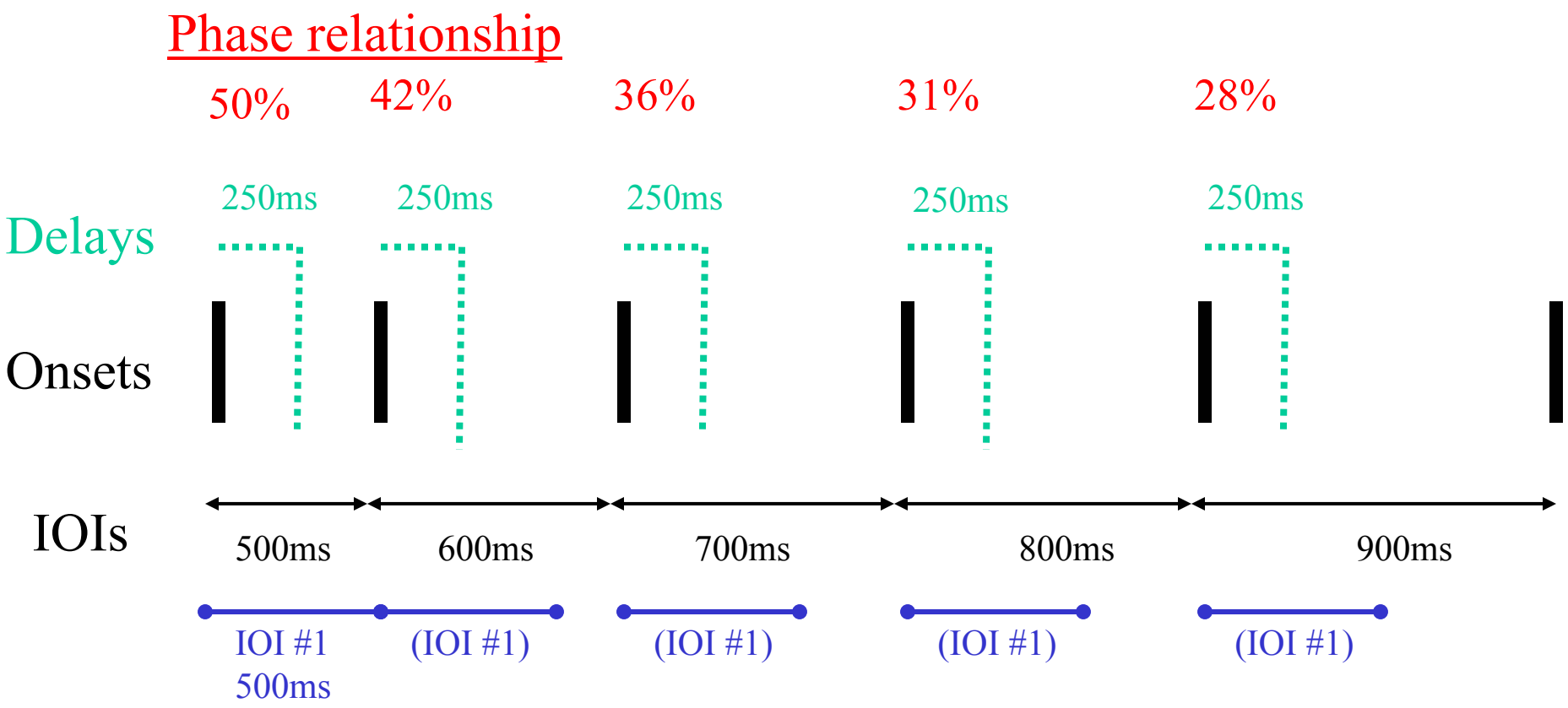
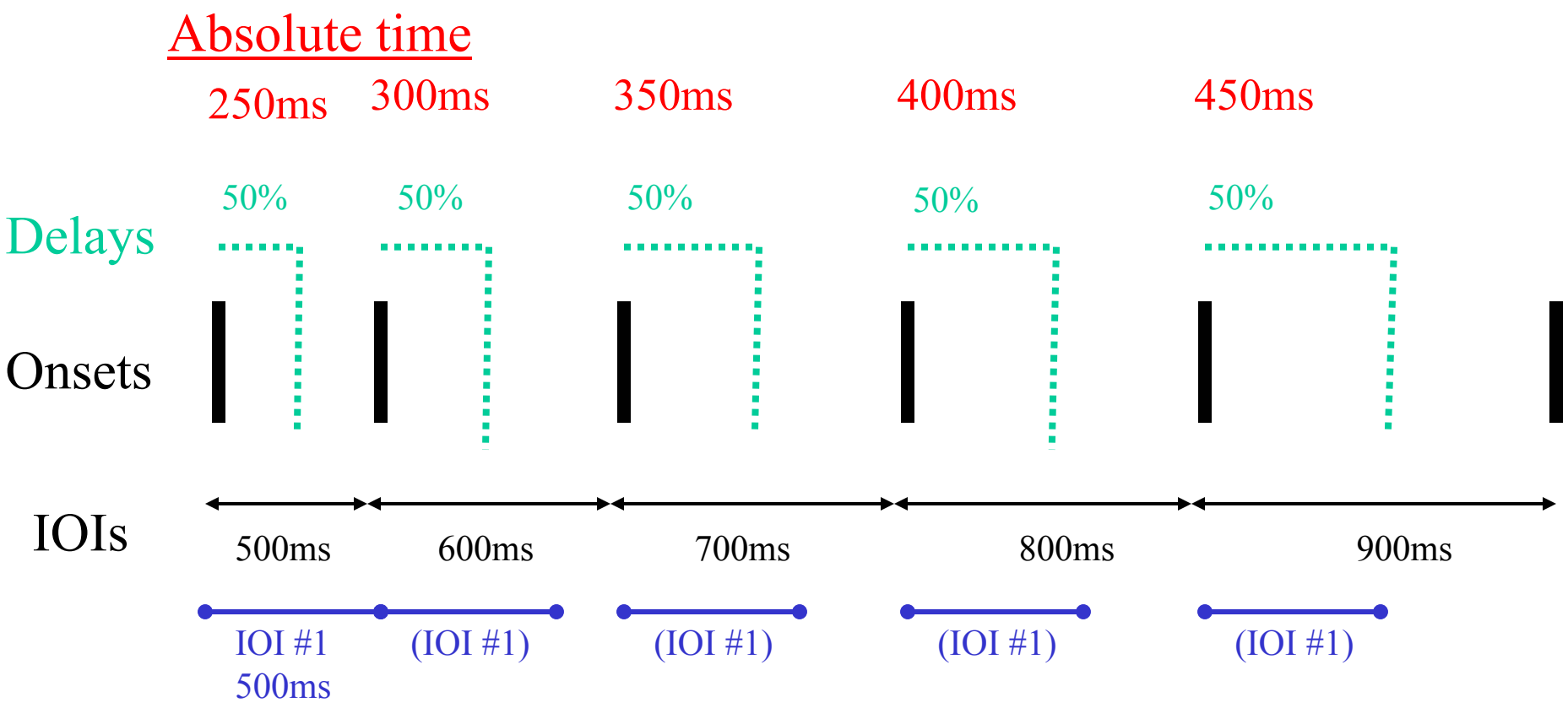
Background

- Altered auditory feedback paradigm
  - Disruption from Delayed Auditory Feedback (DAF, Black, 1951; Lee, 1950)
- What does DAF disruption mean about temporal coordination between timing of actions and feedback?
  - Absolute time hypothesis (e.g., MacKay, 1987)
  - Relative time hypothesis (e.g., Finney & Warren, 2003; Howell et al., 1983; Pfordresher & Palmer, 2002)
- Limitation: Delay lengths fixed

Fixed delays and phase



Adjustable delays and absolute time

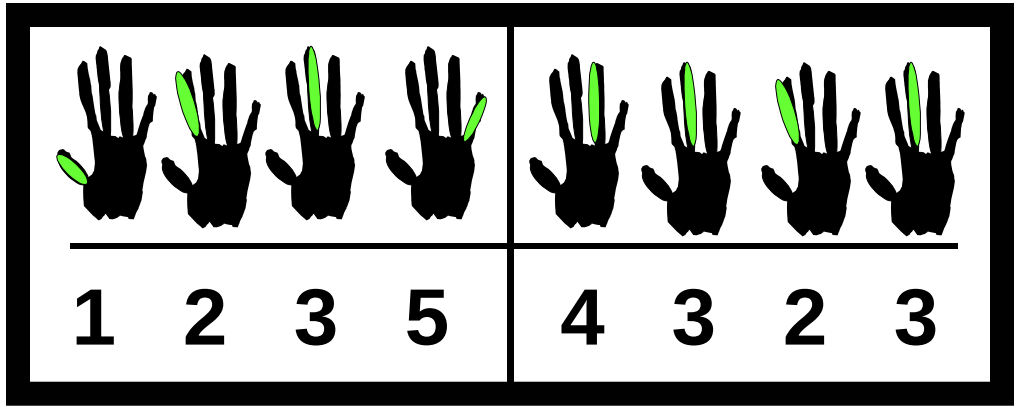


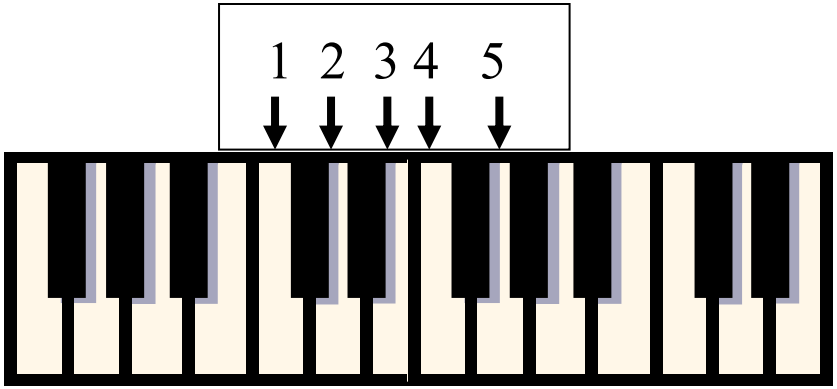
Predictions

- Relative time hypothesis
  - Advantage for delays that crate onset synchrony (100% , 200%), possibly also 50% (alternation)
  - Tempo x delay interaction for fixed delays, but not for adjustable delays
- Absolute time hypothesis
  - Disruption maximal for ~ 200ms delay (270 ms according to Gates et al., 1974).
    - Presume range from 200 – 300ms
    - Disruption may asymptote (e.g., Howell et al., 1983) or decrease (e.g., Fairbanks & Guttman, 1954) after critical interval
  - Tempo x delay interaction for adjustable, not fixed

Experiment 1 Method

- Participants = 12 non-pianists
- Synchronization/Continuation paradigm
- Movement type / task complexity
  - Tap: Isochronous tapping
  - Sequence: Perform melody on keyboard (simplified)





Experiment 1 Method (continued)

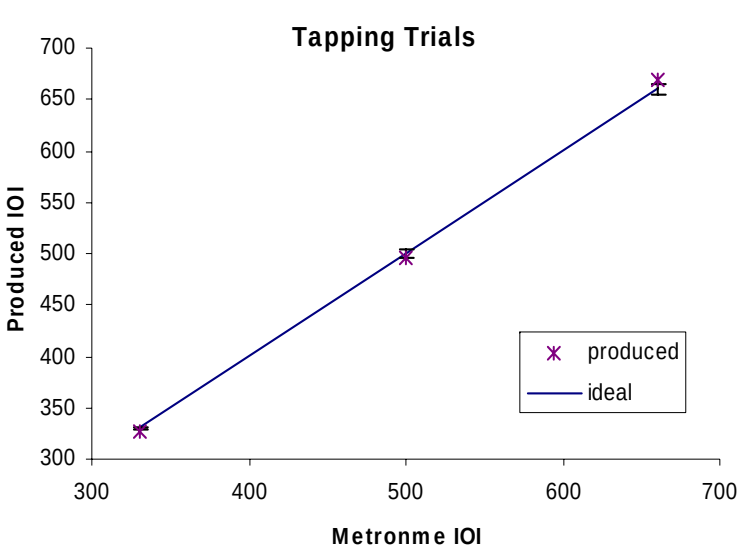
- Delay type (in addition to normal control)
  - Fixed: 330ms, 500ms, 660ms
  - Adjustable: 66%, 100%, 132%
- Tempo (IOI): 330ms, 500ms, 660ms

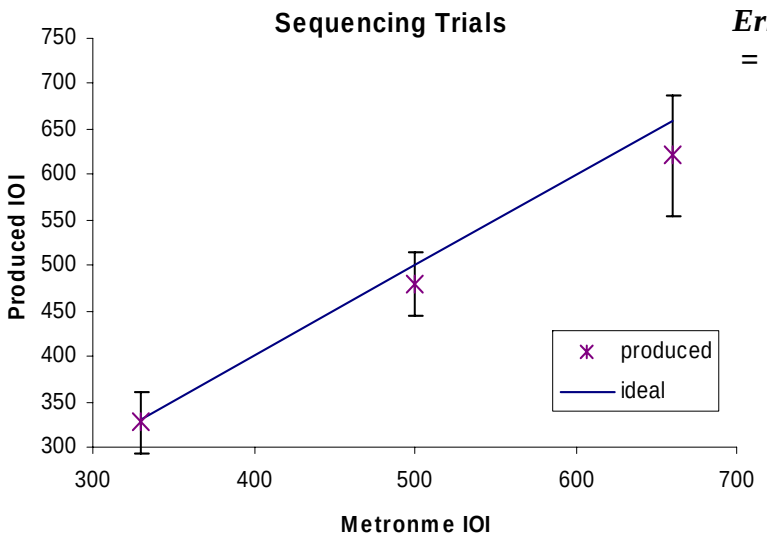
tempo	fixed delay values		
	330	500	660
330	**1**	1.52	**2**
500	0.66	**1**	1.32
660	0.5	0.76	**1**

tempo	adjustable delay values		
	0.66	1	1.2
330	**217.8**	330	396
500	330	500	600
660	435.6	660	792

Data Analysis

- Disruption = Mean IOI (Continuation) – Mean IOI (synchronization)
  - Removed errors (< 5%) and events following errors
  - Removed outliers (+/- 3 SD) and any < 100 or > 1000
- Synchronization performance (+/- 1 SD):

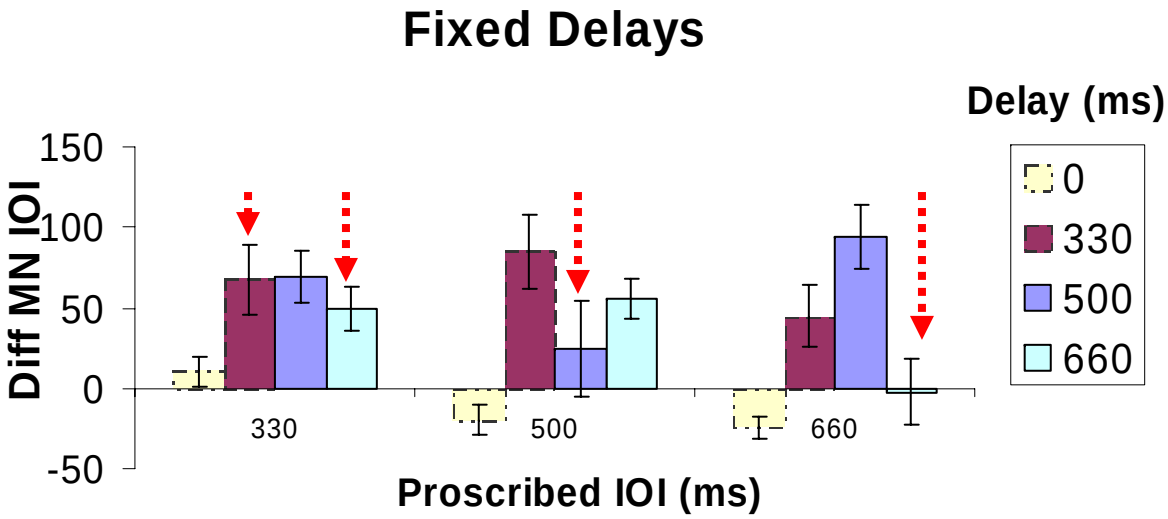




Error bars = +/- 1 SD

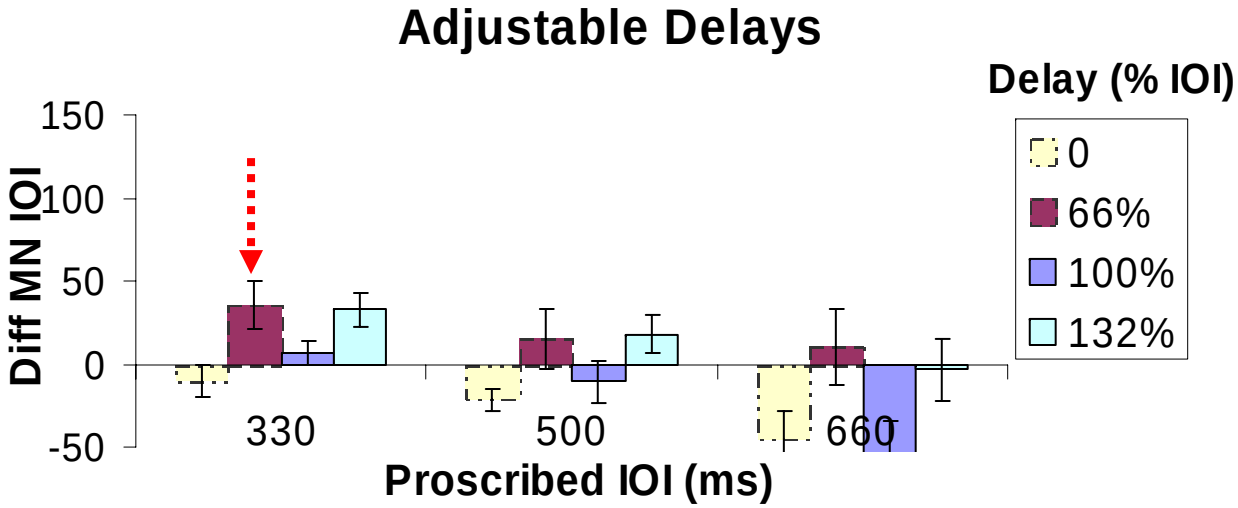
Results: Sequencing Trials

Arrows = Integer phase (predict low)



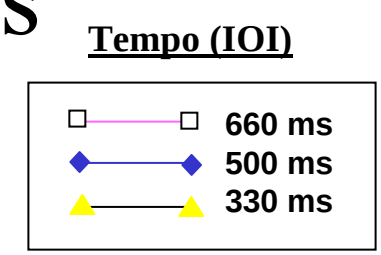
Error bars = +/- 1 SE

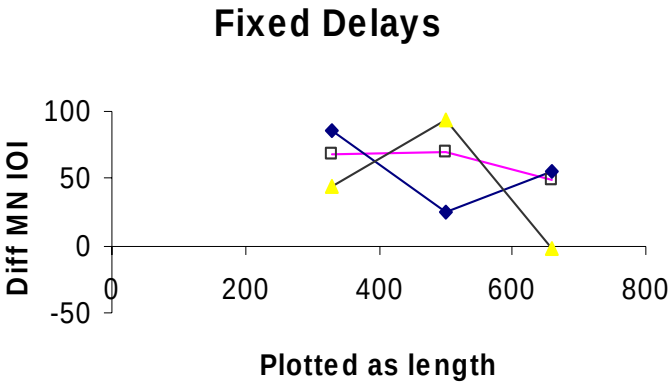
Arrows = 200-300 ms (predict high)

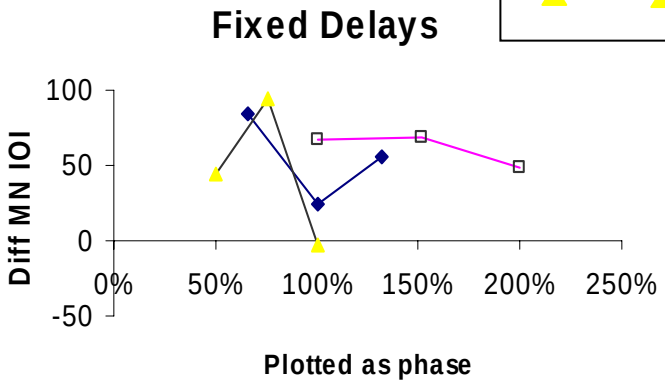


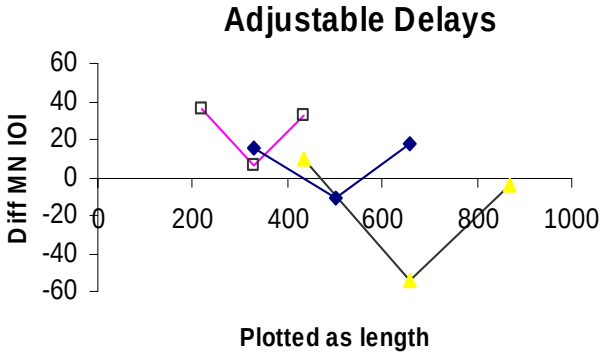
Results: Sequencing Trials

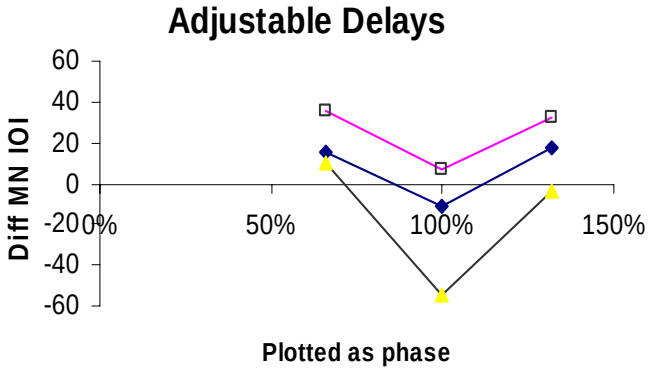
Delays on different continua





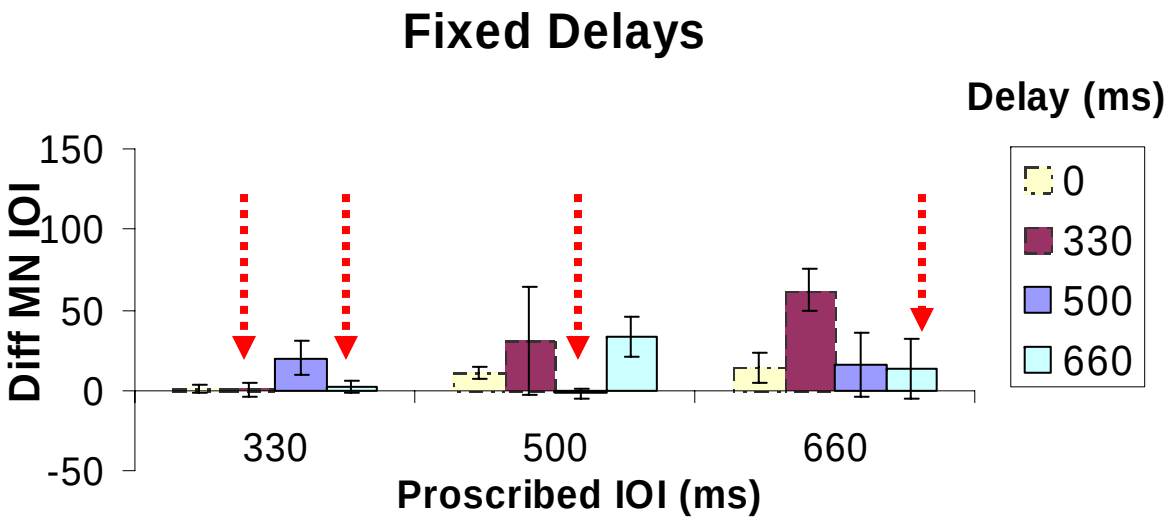




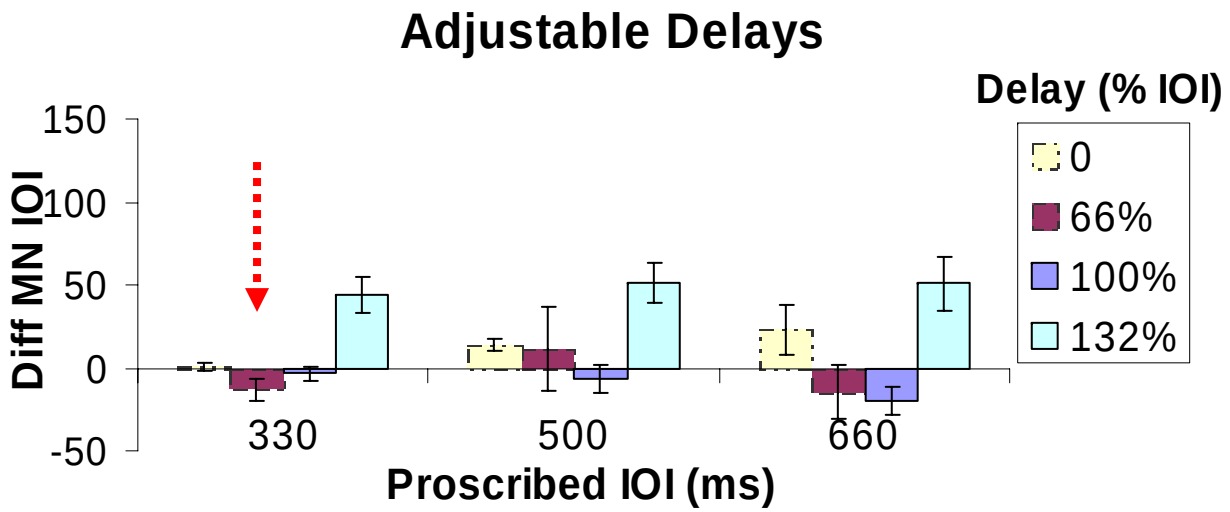


Results: Tapping Trials

Arrows = Integer phase (predict low)

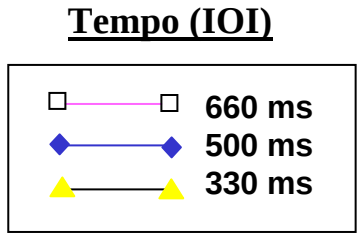


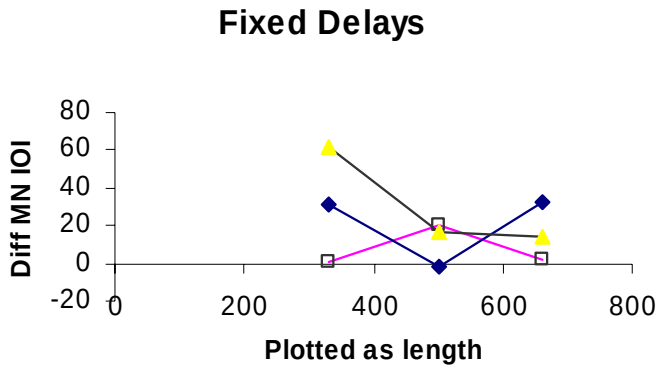
Arrows = 200-300 ms (predict high)

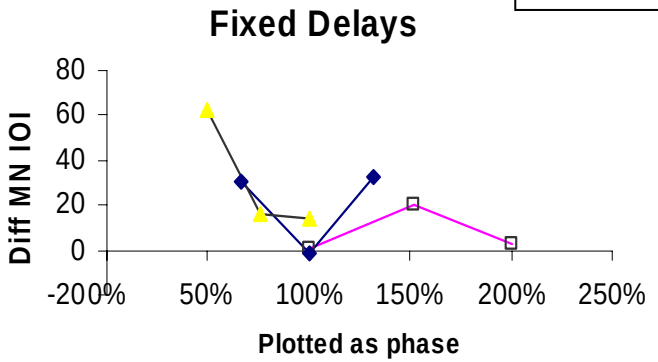


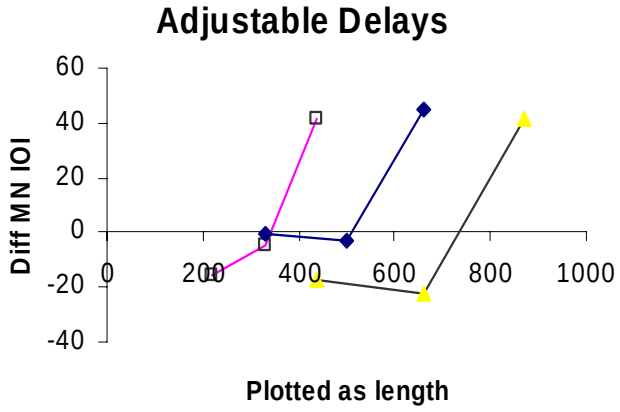
Results: Tapping Trials

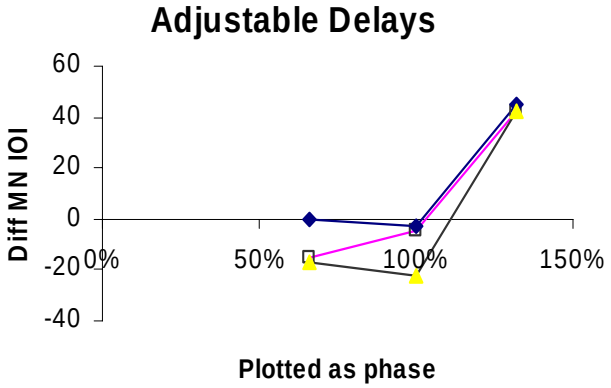
Delays on different continua











Experiment 2: Short delays

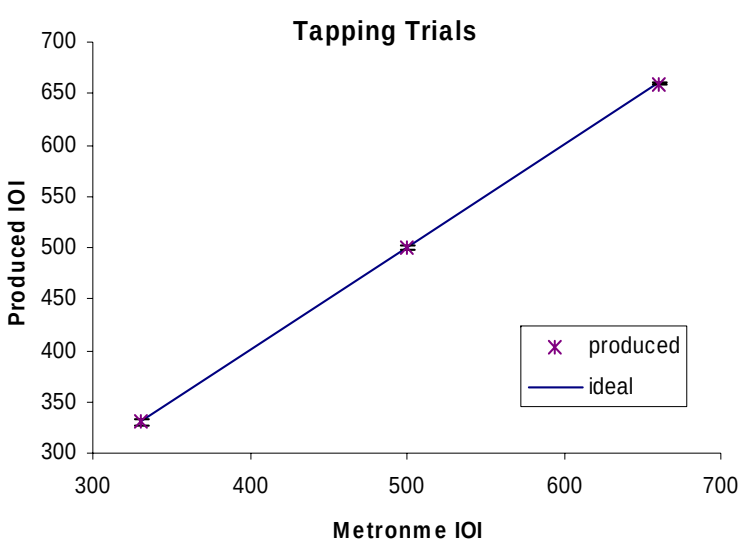
- Experiment 1 not ideally suited to test for "peak" around delays of 200ms.
- Phase shifts at 50% may show facilitation (Pfordresher & Palmer, 2002)
- Changed delay amounts
  - Fixed: 165ms, 250ms, 330ms
  - Adjustable: 33%, 50%, 66%

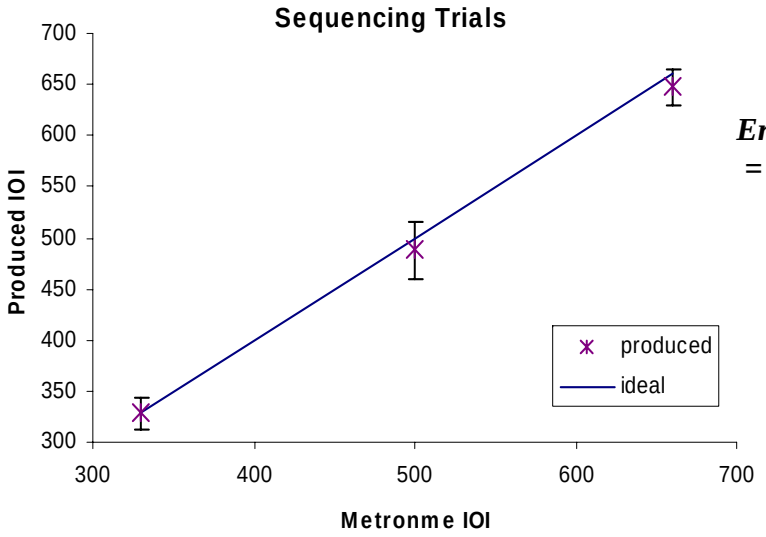
tempo	fixed delay values		
	165	250	330
330	**0.5**	0.76	**1**
500	0.33	**0.5**	0.66
660	0.25	0.38	**0.5**

tempo	adjustable delay values		
	0.33	0.5	0.66
330	108.9	165	**217.8**
500	165	**250**	330
660	**217.8**	330	435.6

Method (continued)

- 12 Additional non-pianists
- Same data analysis
  - Performance on synchronization (+/- 1SD):

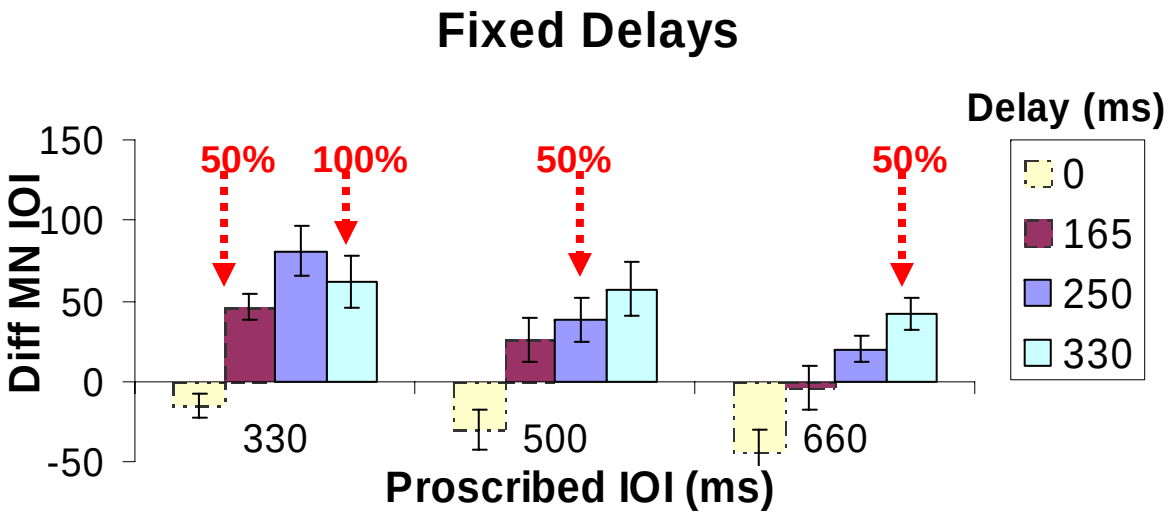




Error bars = +/- 1 SD

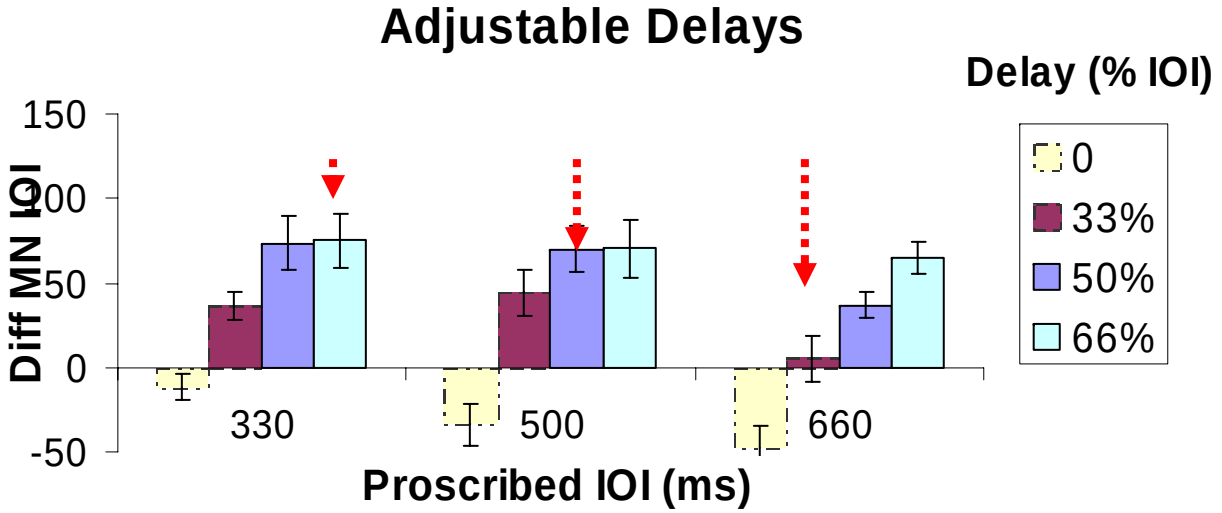
Results: Sequence

Arrows = Integer phase (predict low)



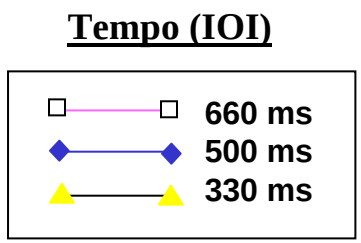
Error bars = +/- 1 SE

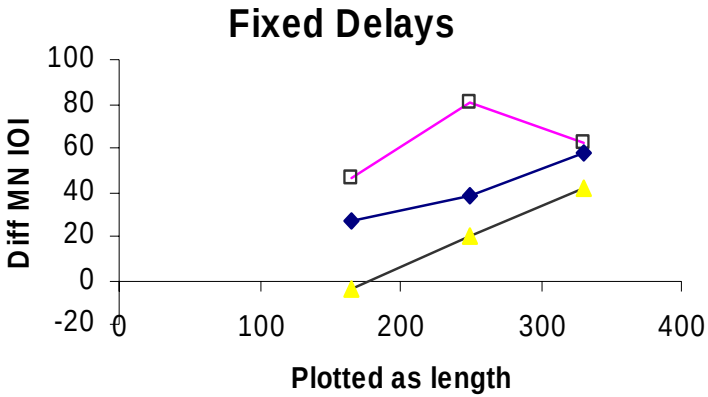
Arrows = 200-300 ms (predict high)

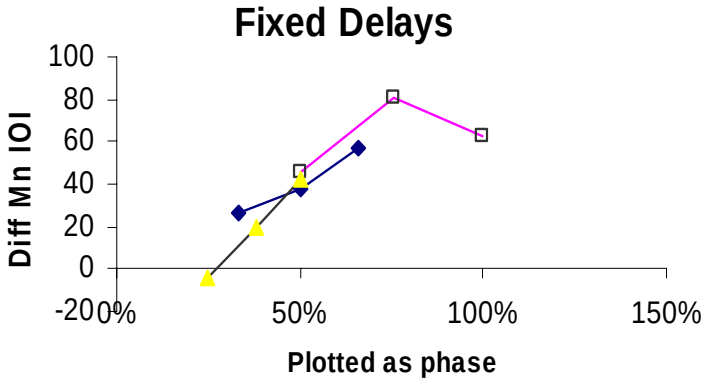


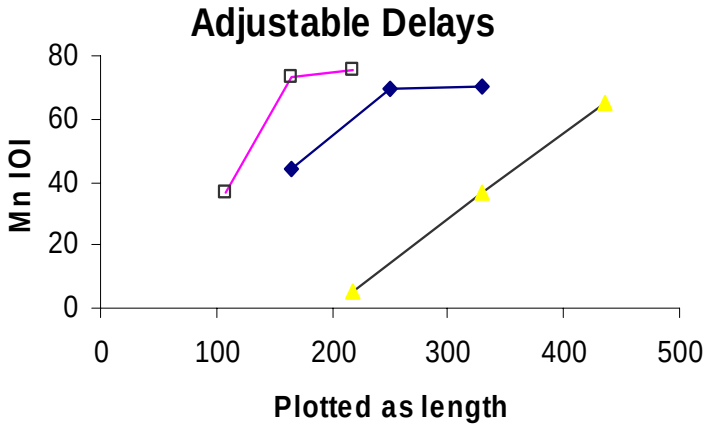
Results: Sequence

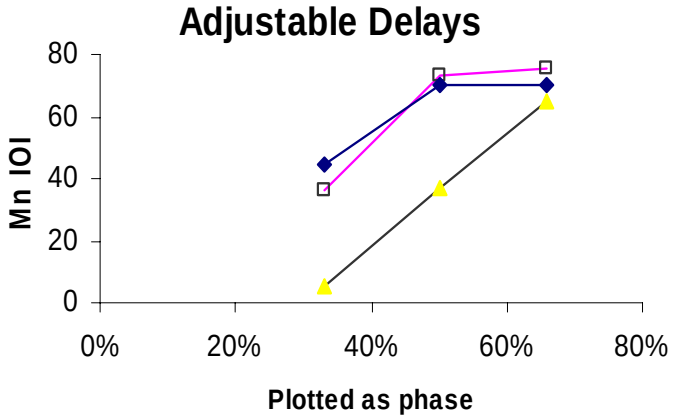
Delays on different continua





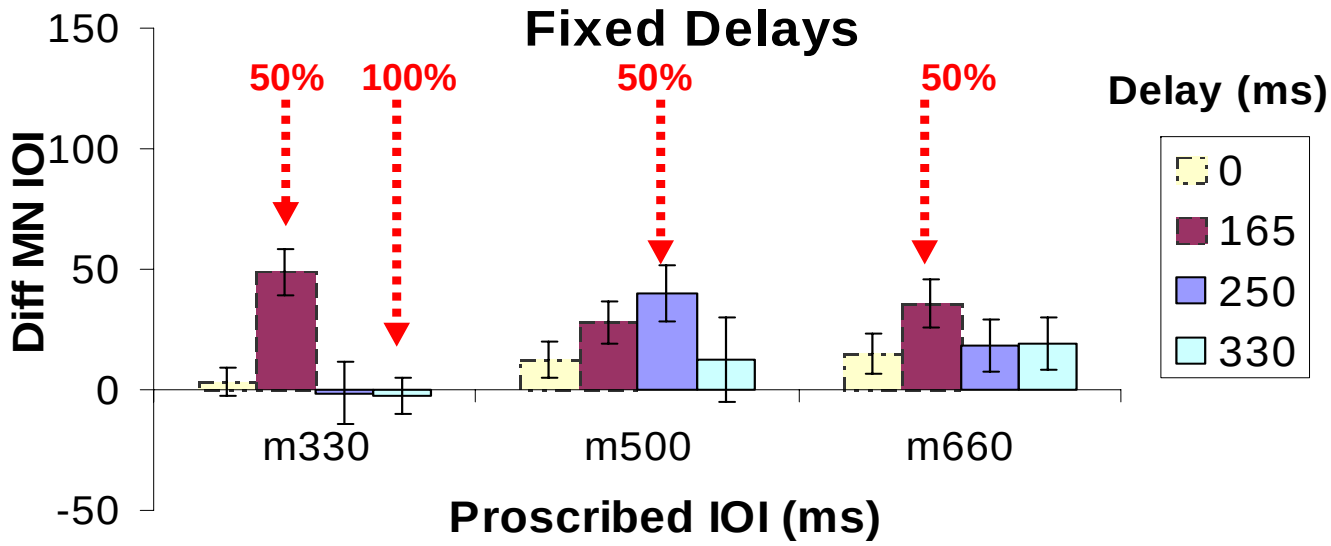




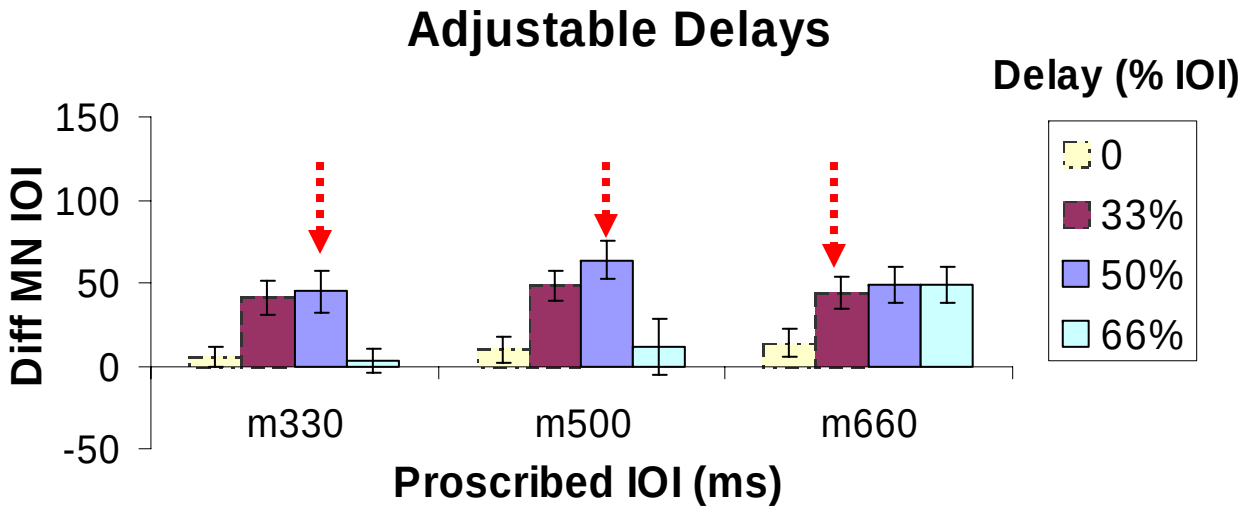


Results: Tapping Trials

Arrows = Integer phase (predict low)

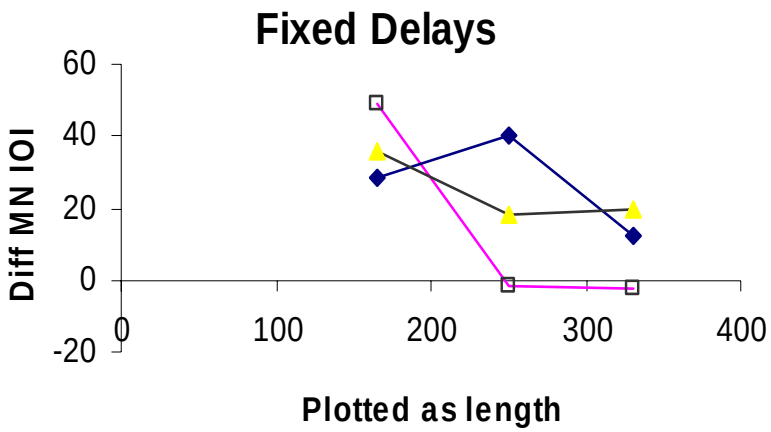


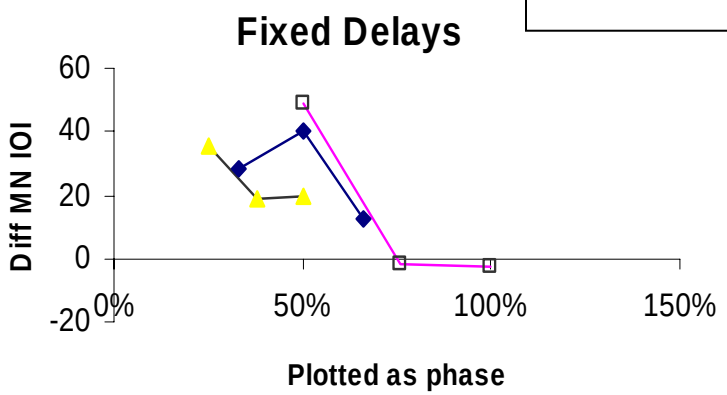
Arrows = 200-300 ms (predict high)

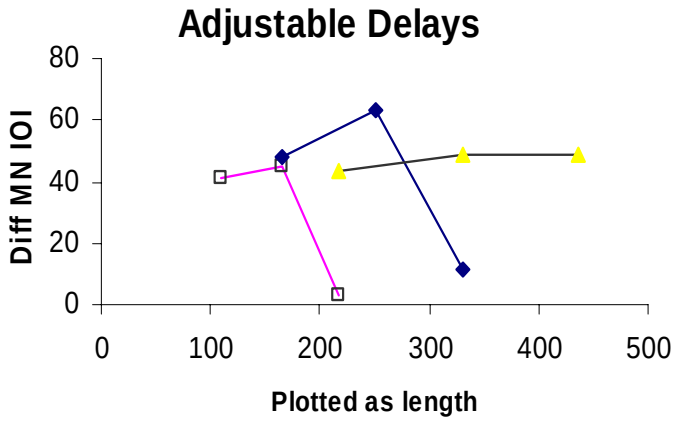


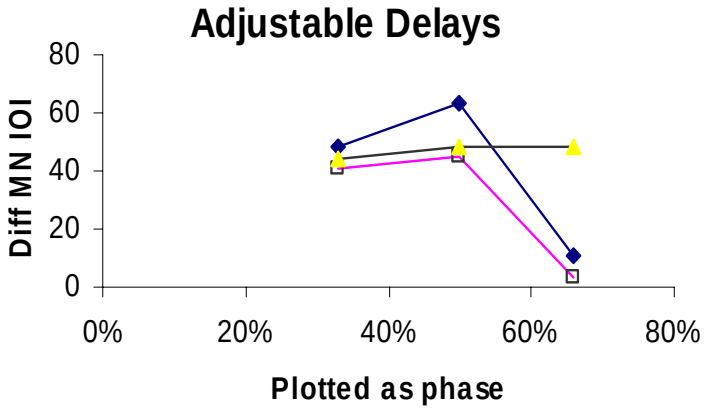
Results: Tapping Trials

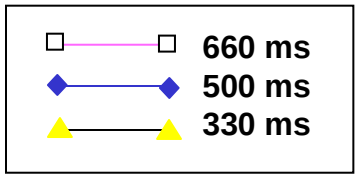
Delays on different continua



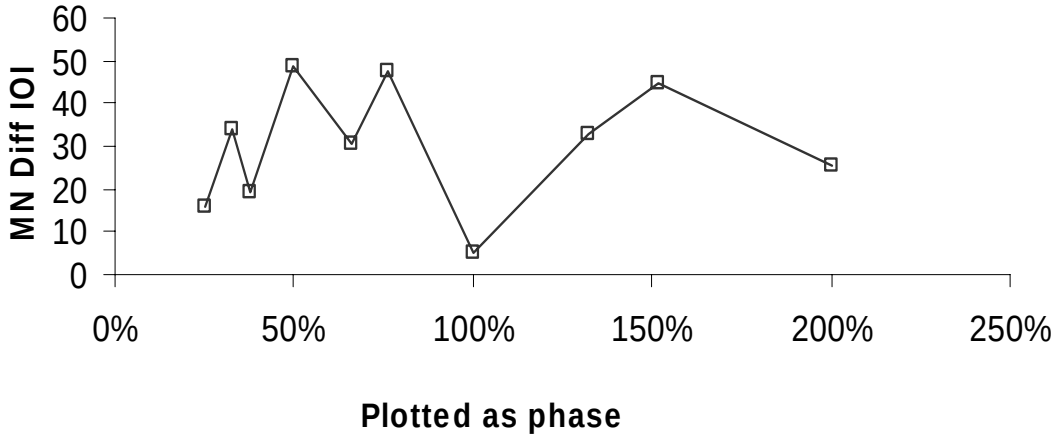


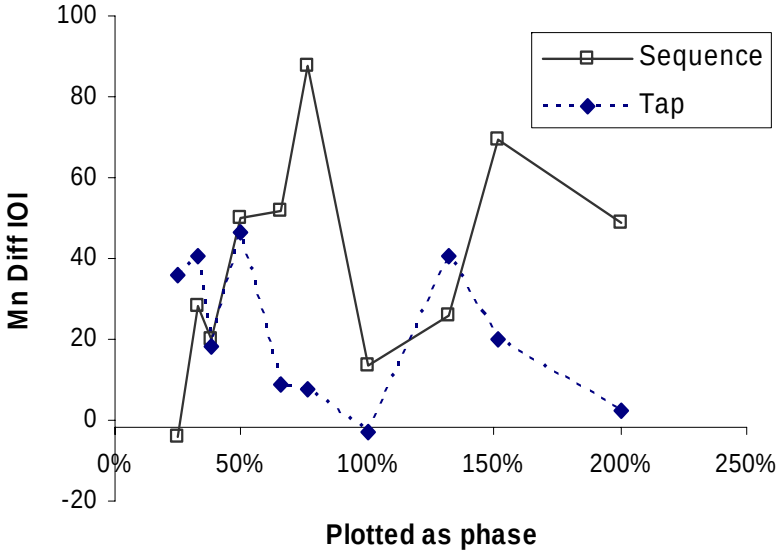


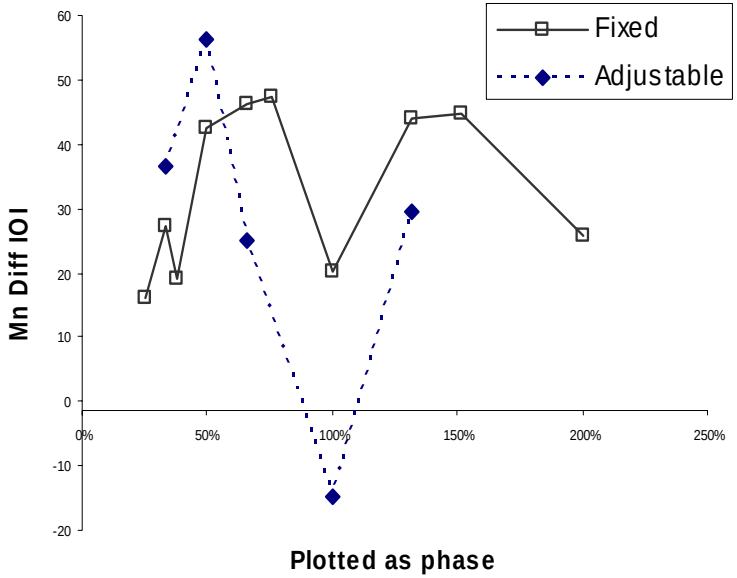




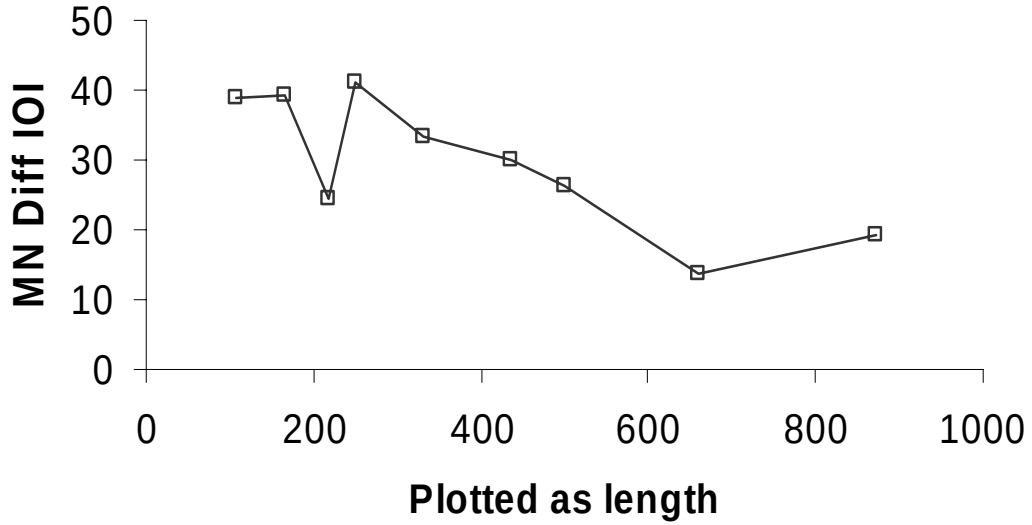
Both Experiments: Phase

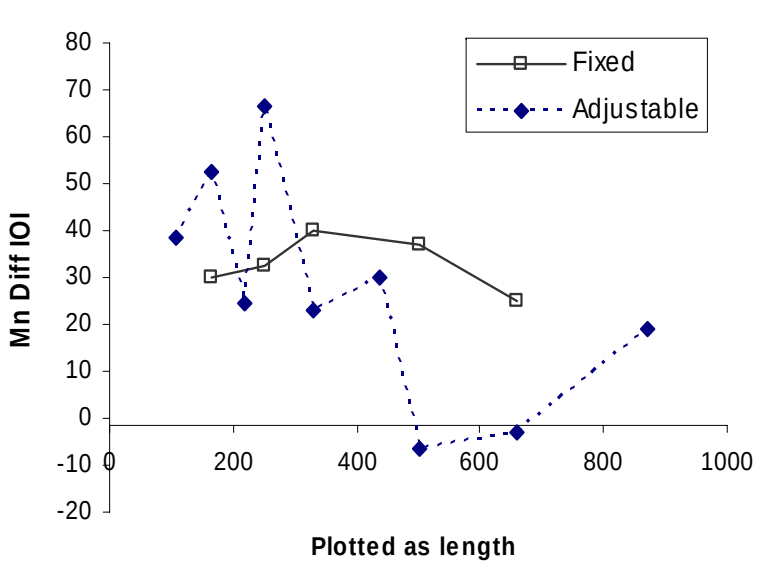


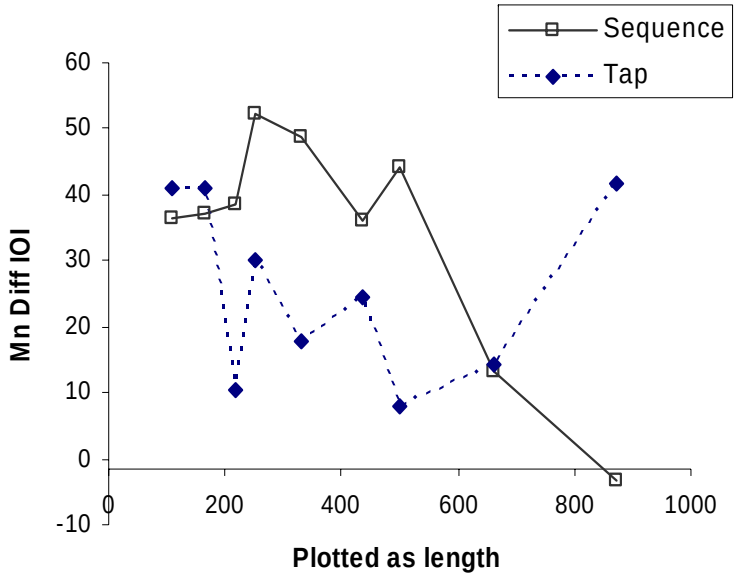




Both Experiments: Length







Conclusions

- Evidence for an advantage of simple phase ratios (but not .5), regardless of delay type or movement type
  - *Maximal* disruption around θ = .50 - .75, depending on movement type
- Weaker effects of absolute time may also contribute
  - Global influence across tempo conditions, not evident within each tempo condition
  - More apparent for adjustable delays, sequencing

And now, a shameless plug…

Auditory Perception, Cognition, and Action Meeting (APCAM)

Keynote Speaker: Professor Dylan Jones, Cardiff University

Thursday November 10, 2005, Toronto

(Before Psychonomics)

Submission Deadline: August 26, 2005

More information at:

www.apcam.us

mcauley@bgnet.bgsu.edu