

# TEMPORAL INTEGRATION OF DYNAMIC BINAURAL EVENTS

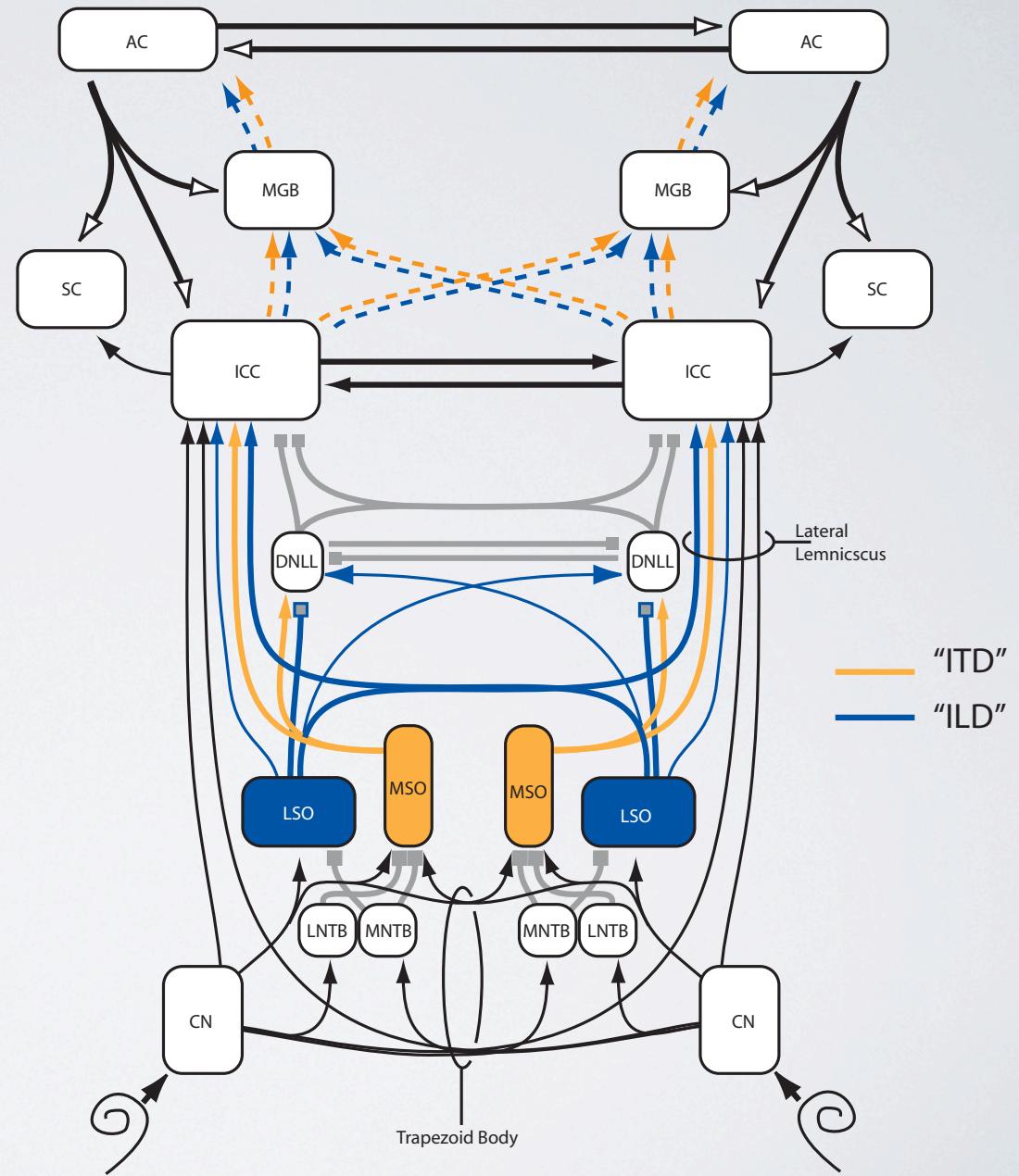
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Julie M. S. Stecker, Anna C. Diedesch, Nathan C. Higgins, Sandra Da Costa

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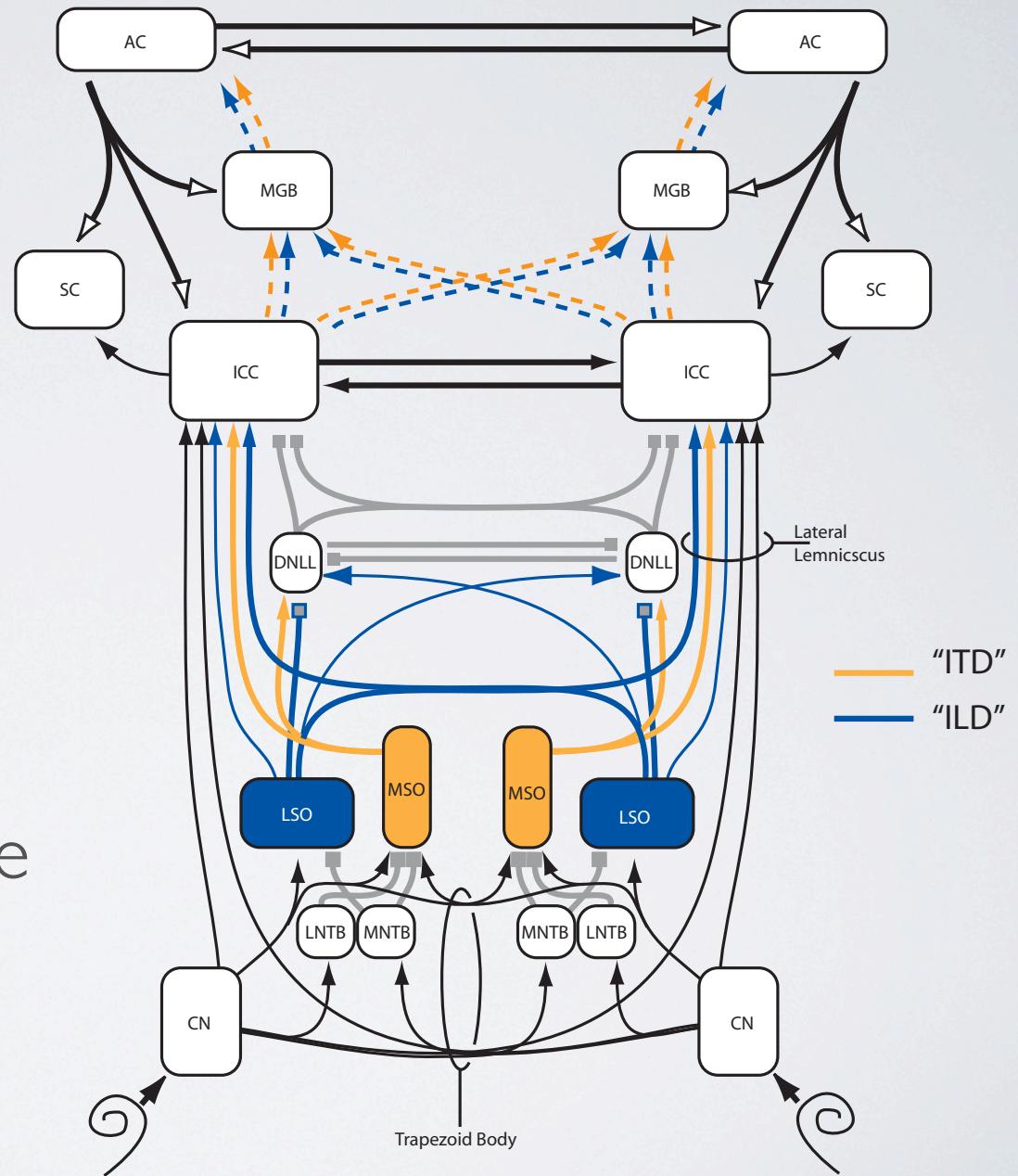
Supported by NIH DC011548

# Sensory integration across binaural cues



# Sensory integration across binaural cues

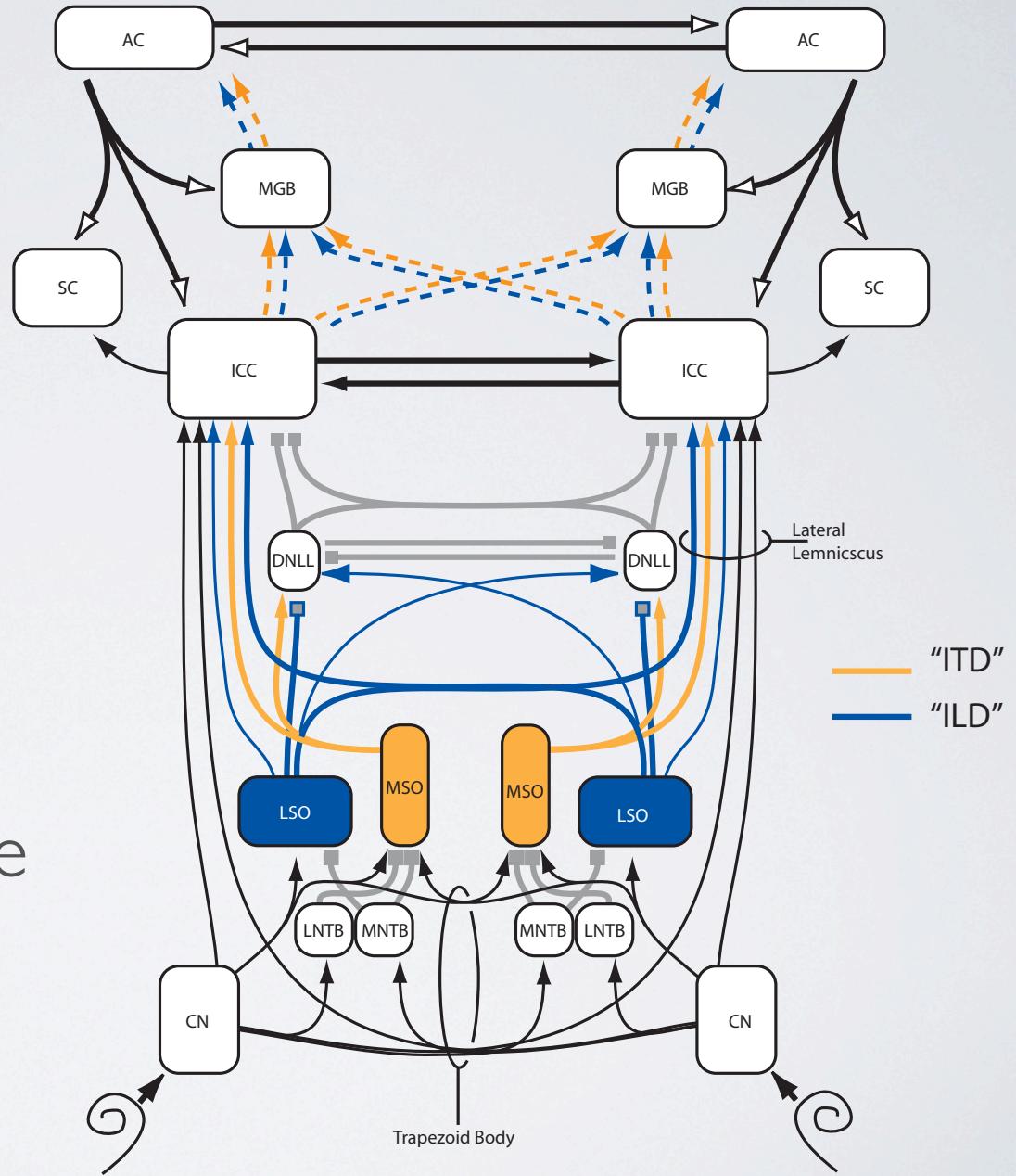
Early integration:  
common binaural code



# Sensory integration across binaural cues

Late integration:  
separate pathways

Early integration:  
common binaural code

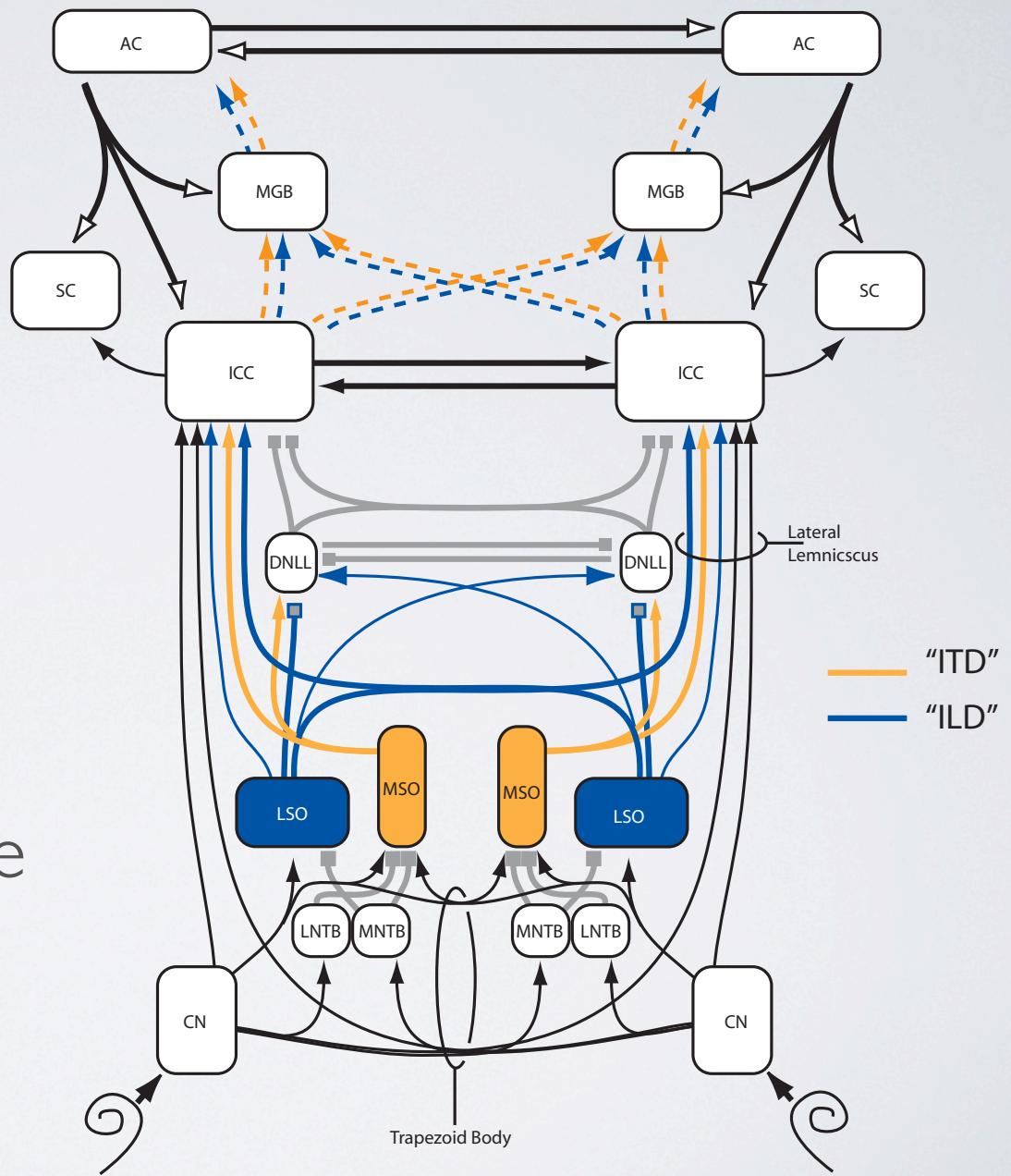


# Sensory integration across binaural cues

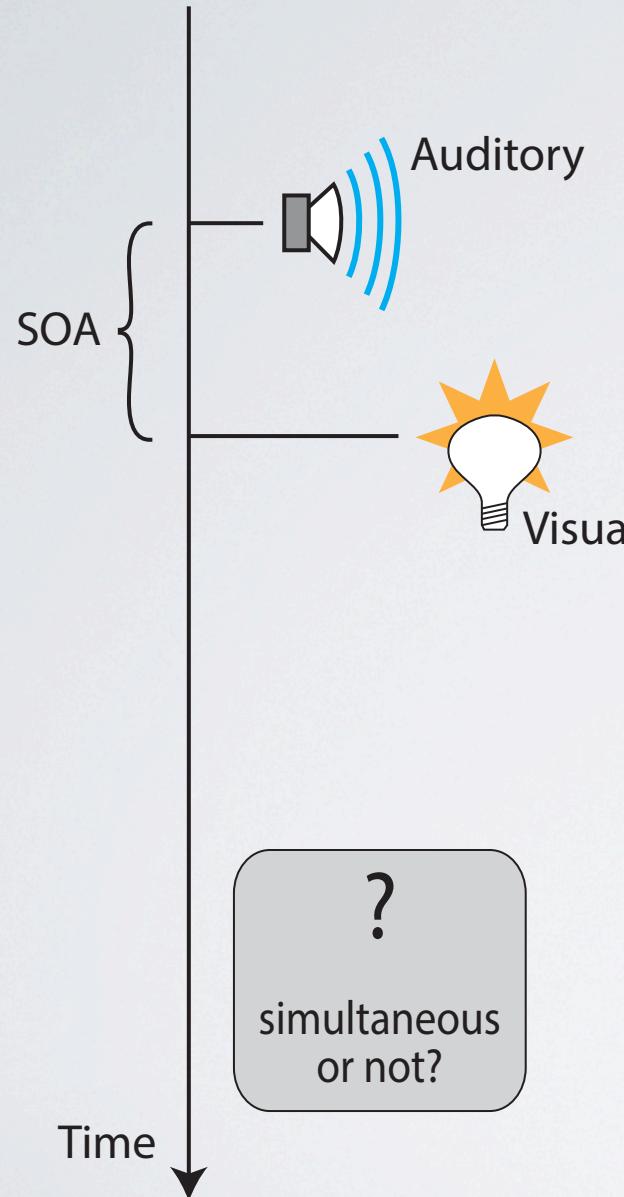
System-specific /  
context-dependent?

Late integration:  
separate pathways

Early integration:  
common binaural code



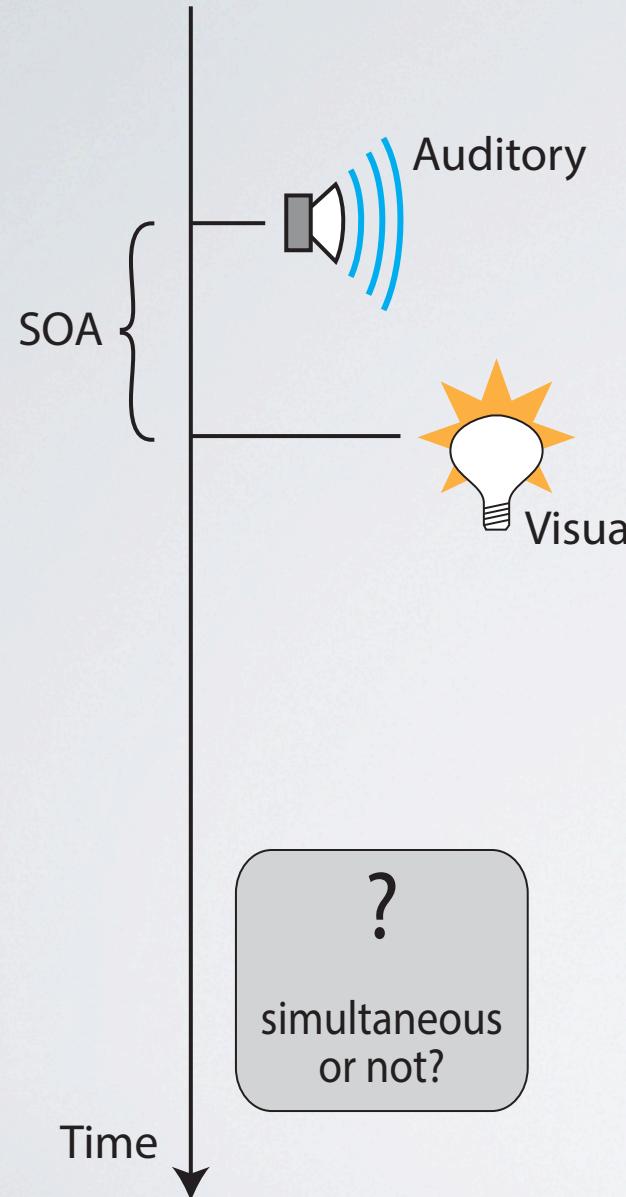
# Simultaneity perception in multisensory integration



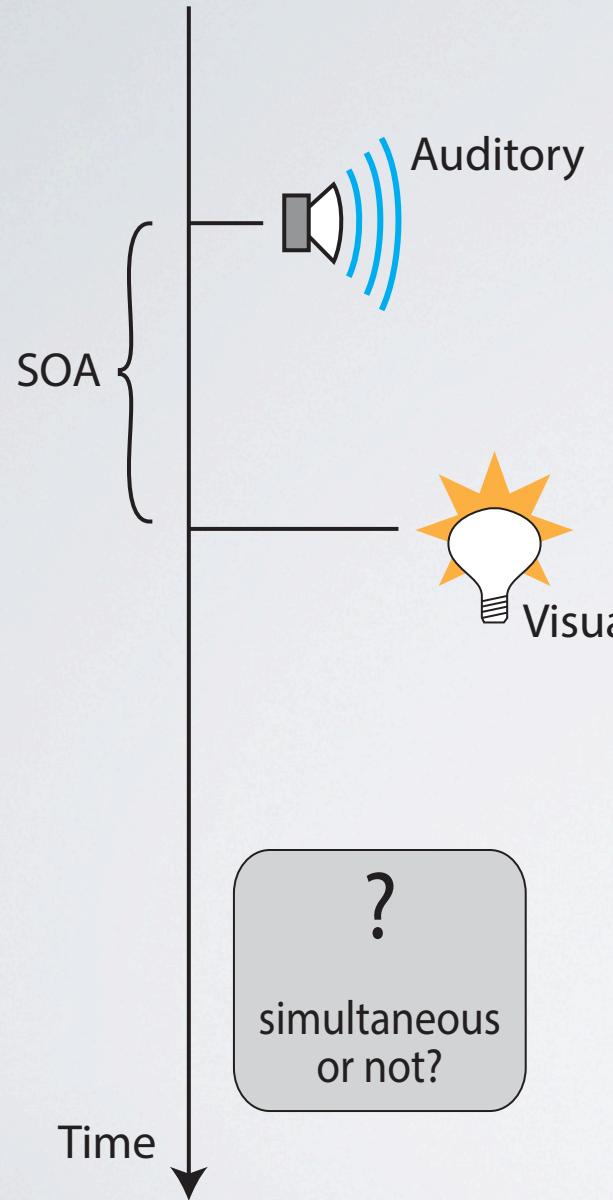
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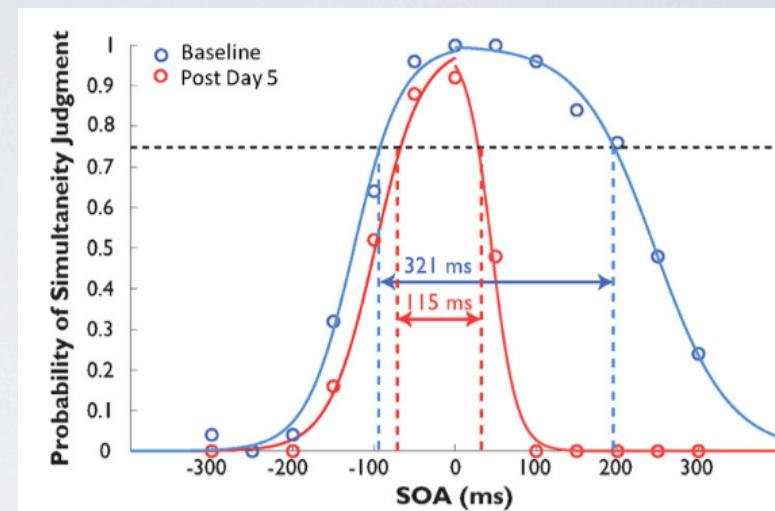
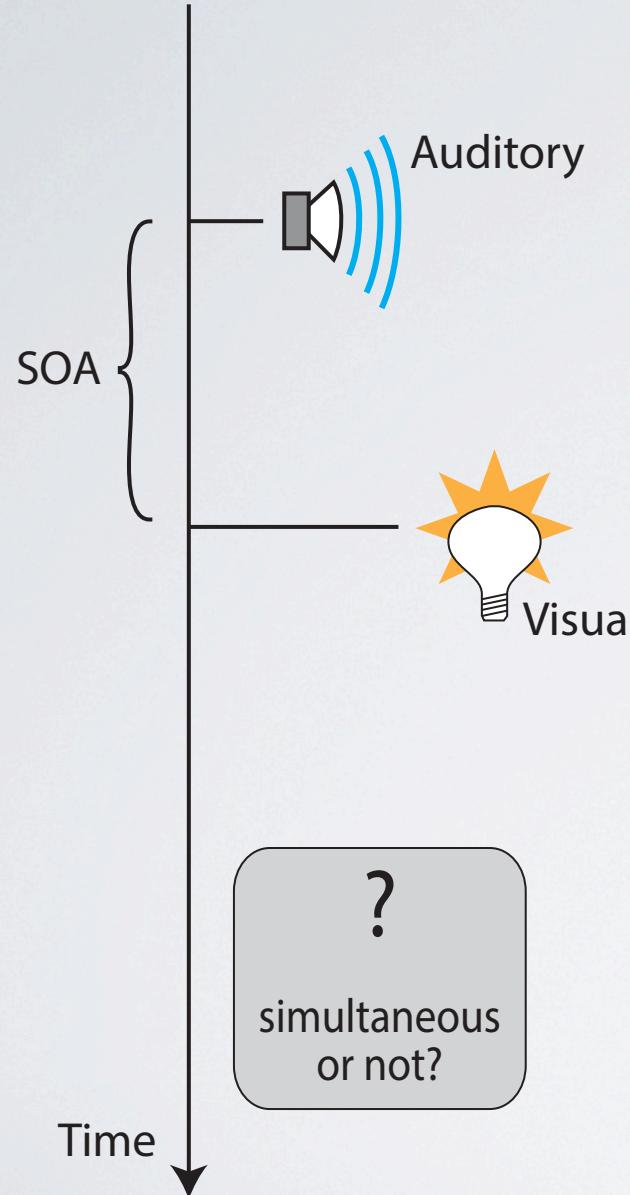
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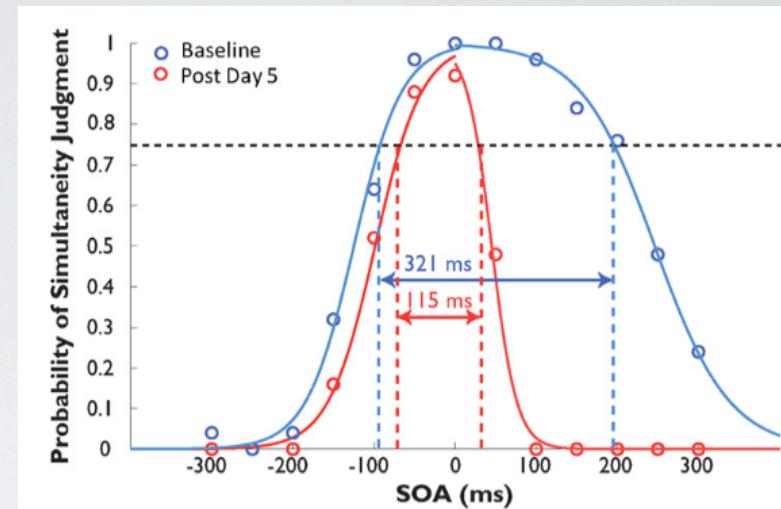
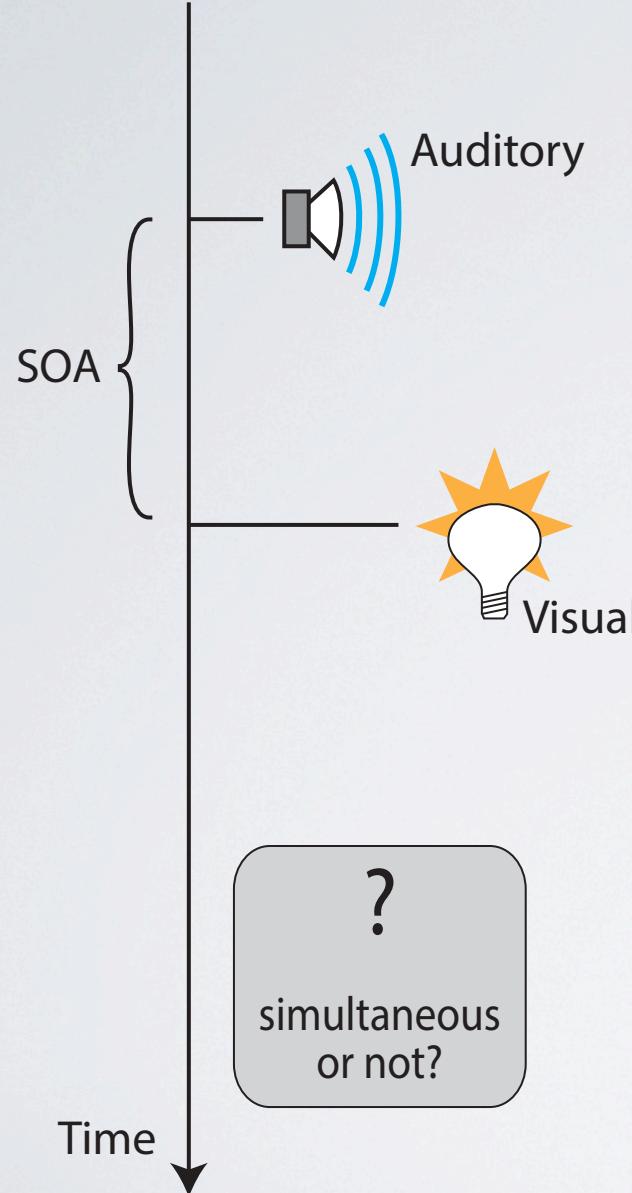


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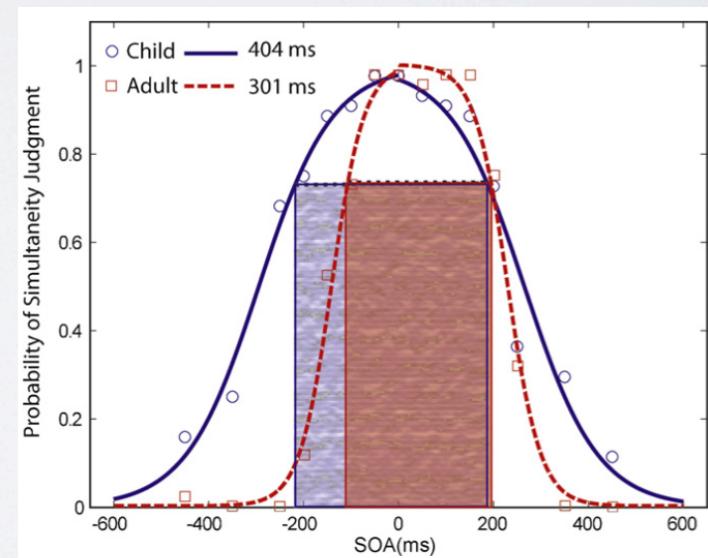


Powers et al. (J Neurosci 2009)

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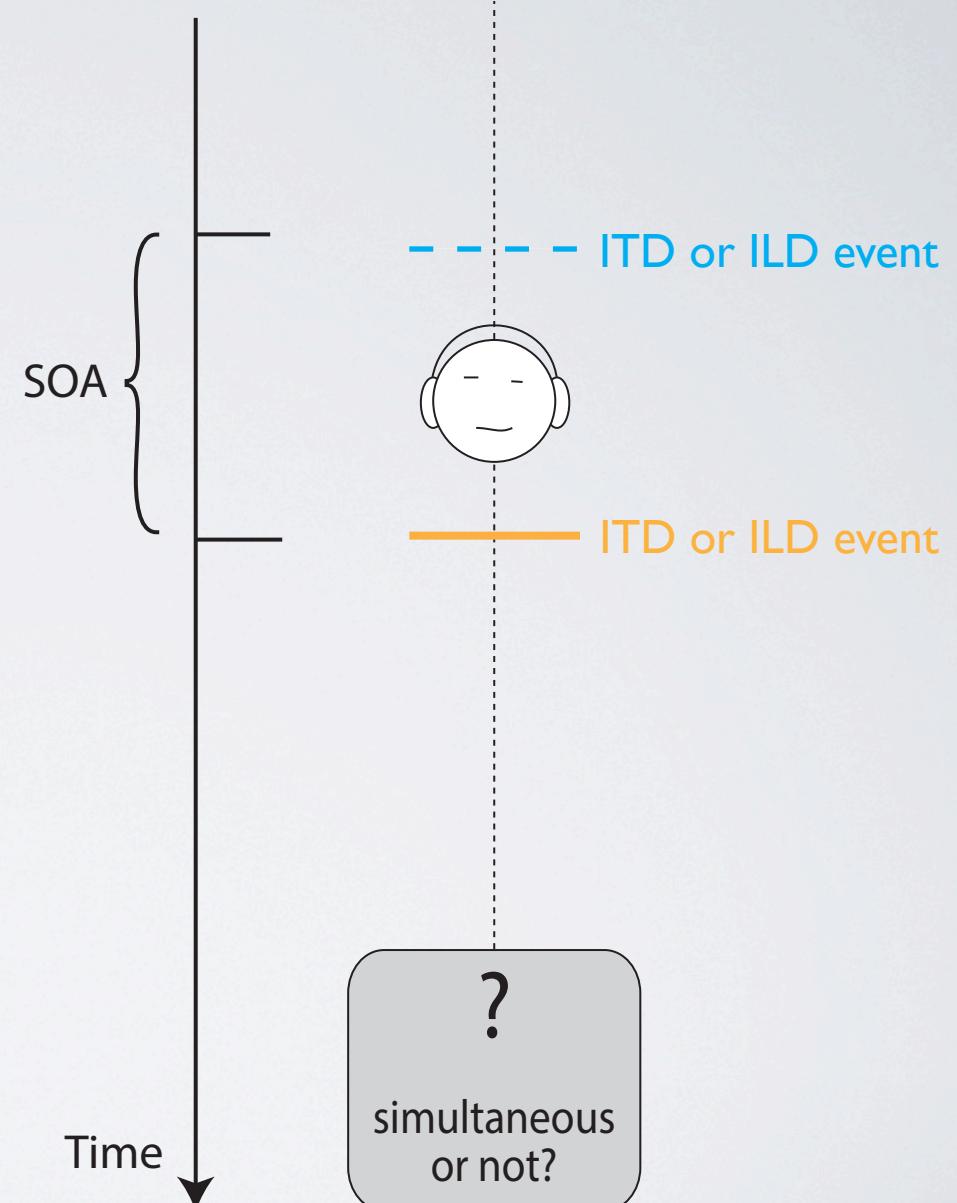
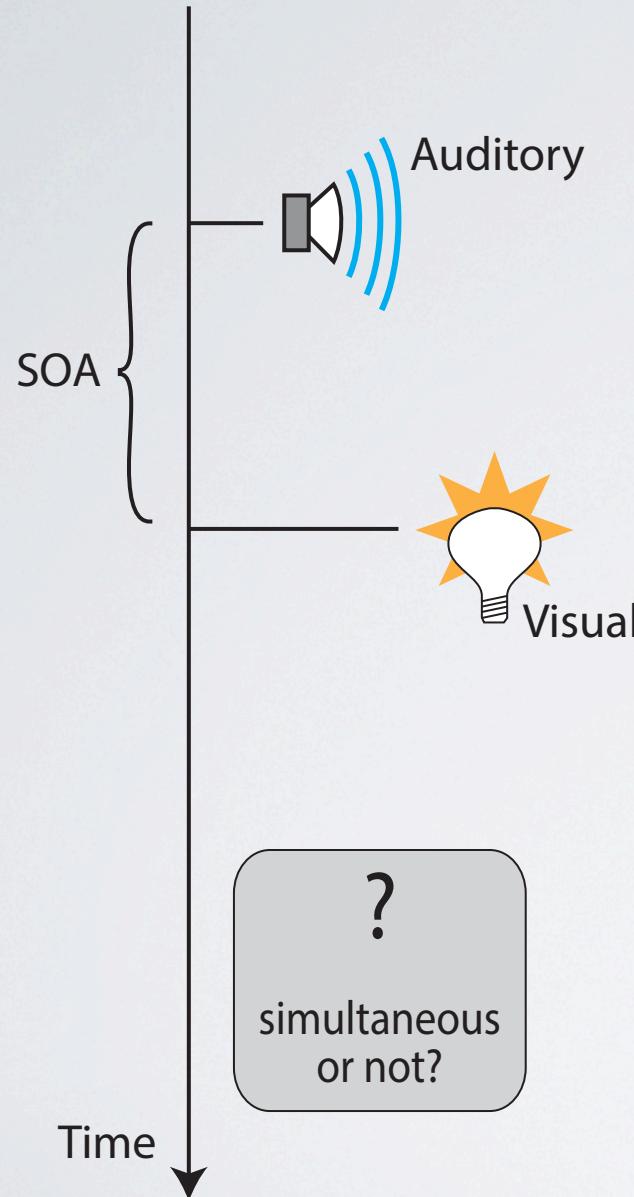


Powers et al. (J Neurosci 2009)

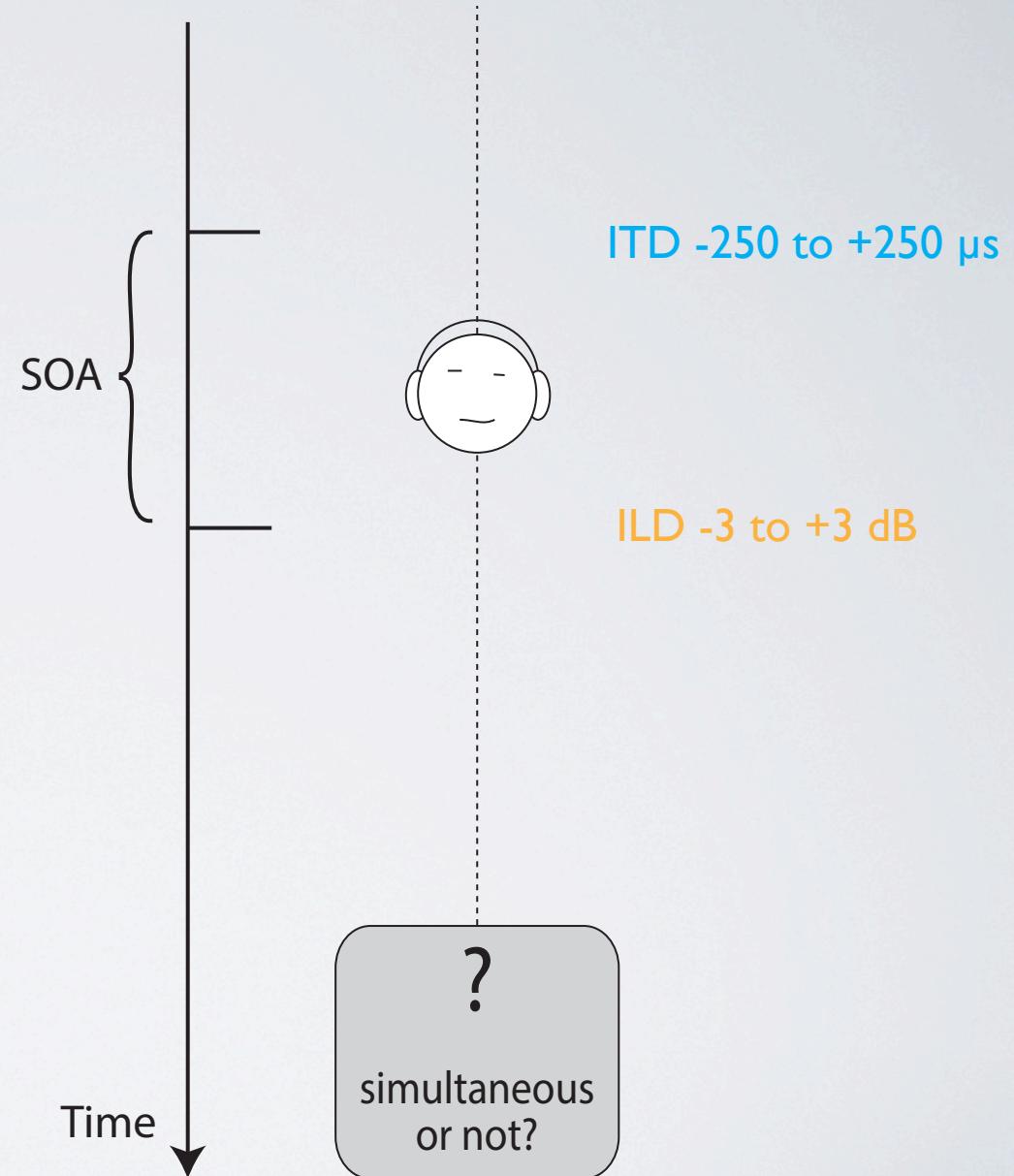


Hillock et al. (Neuropsychologia 2011)

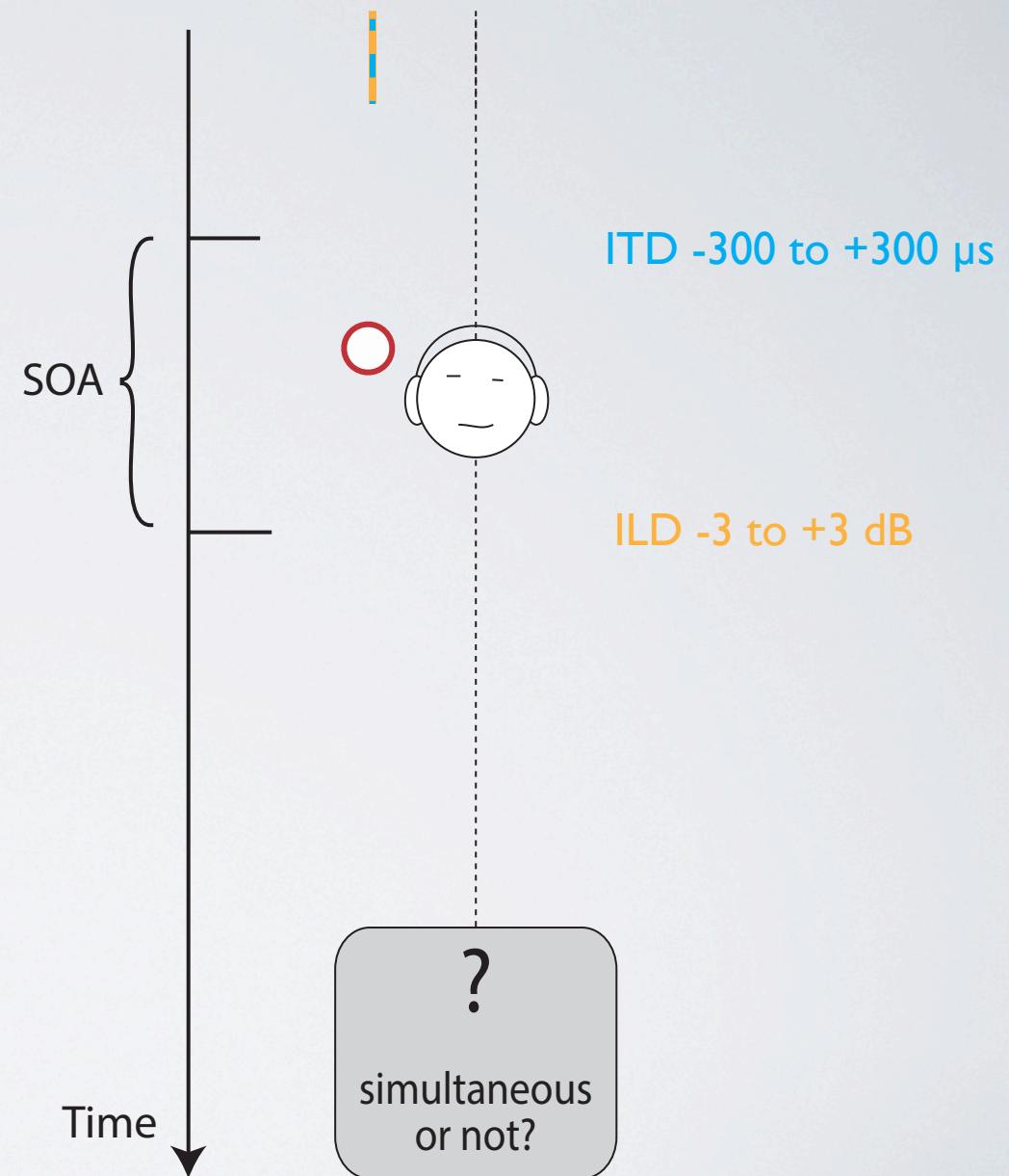
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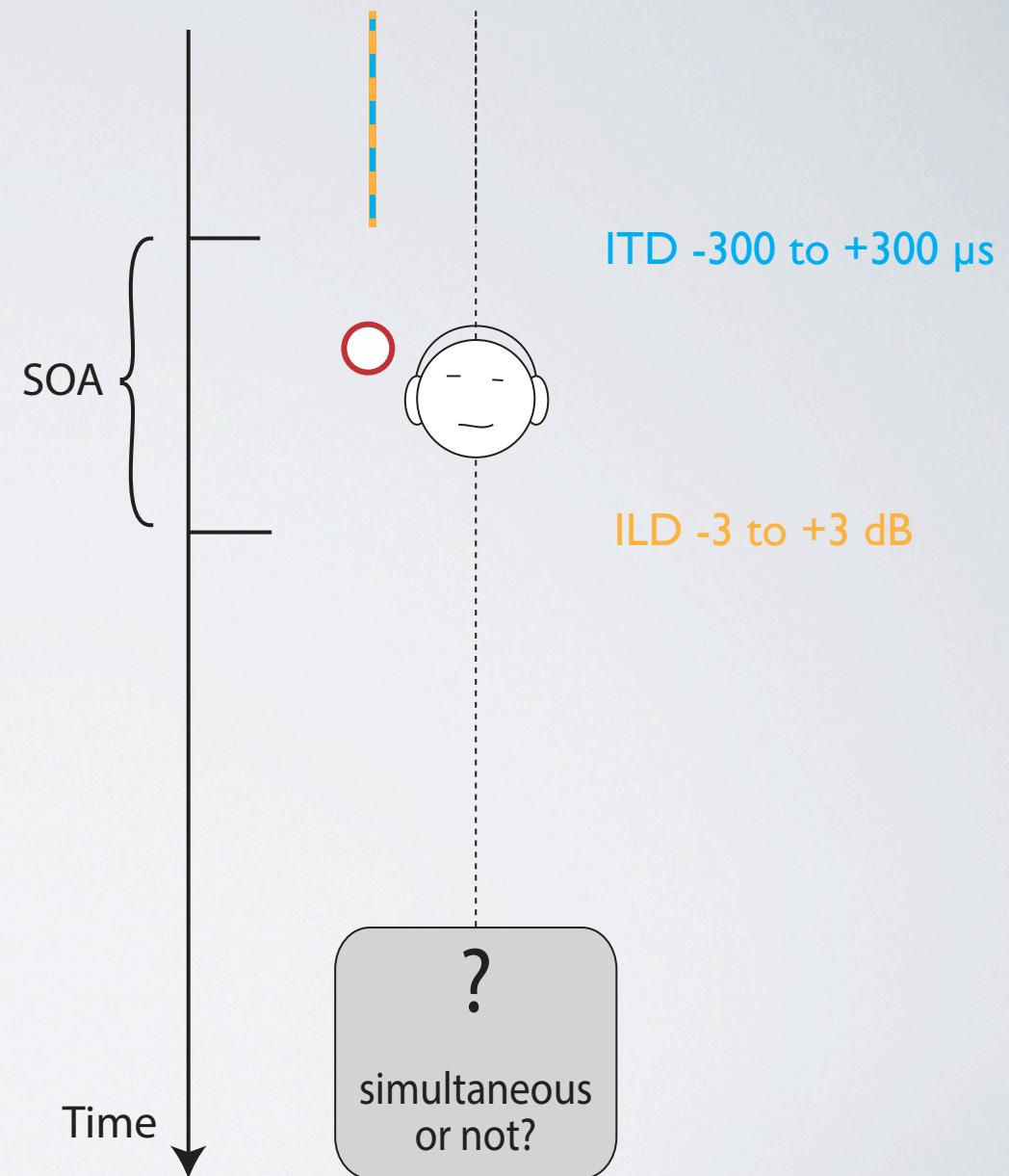
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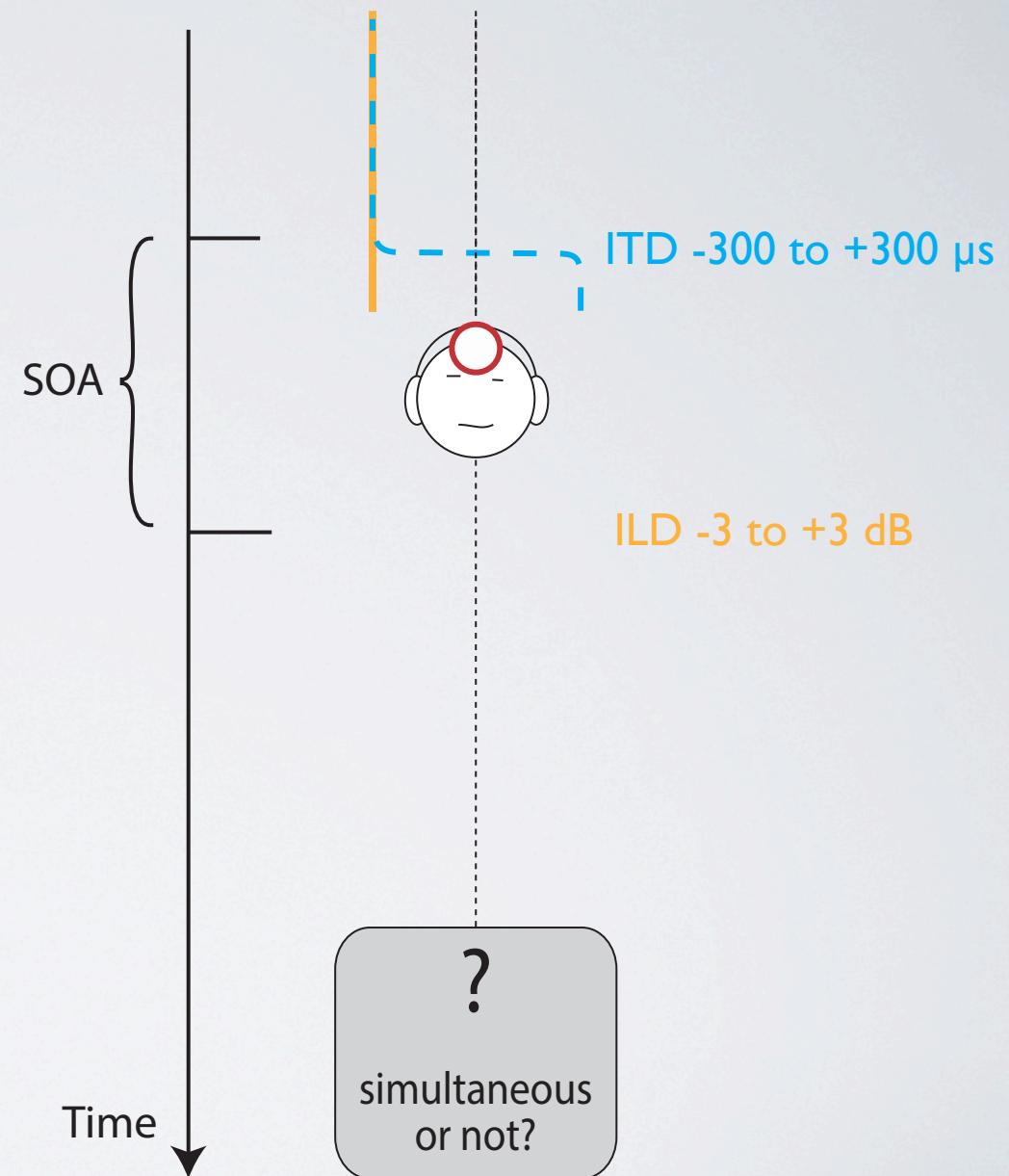
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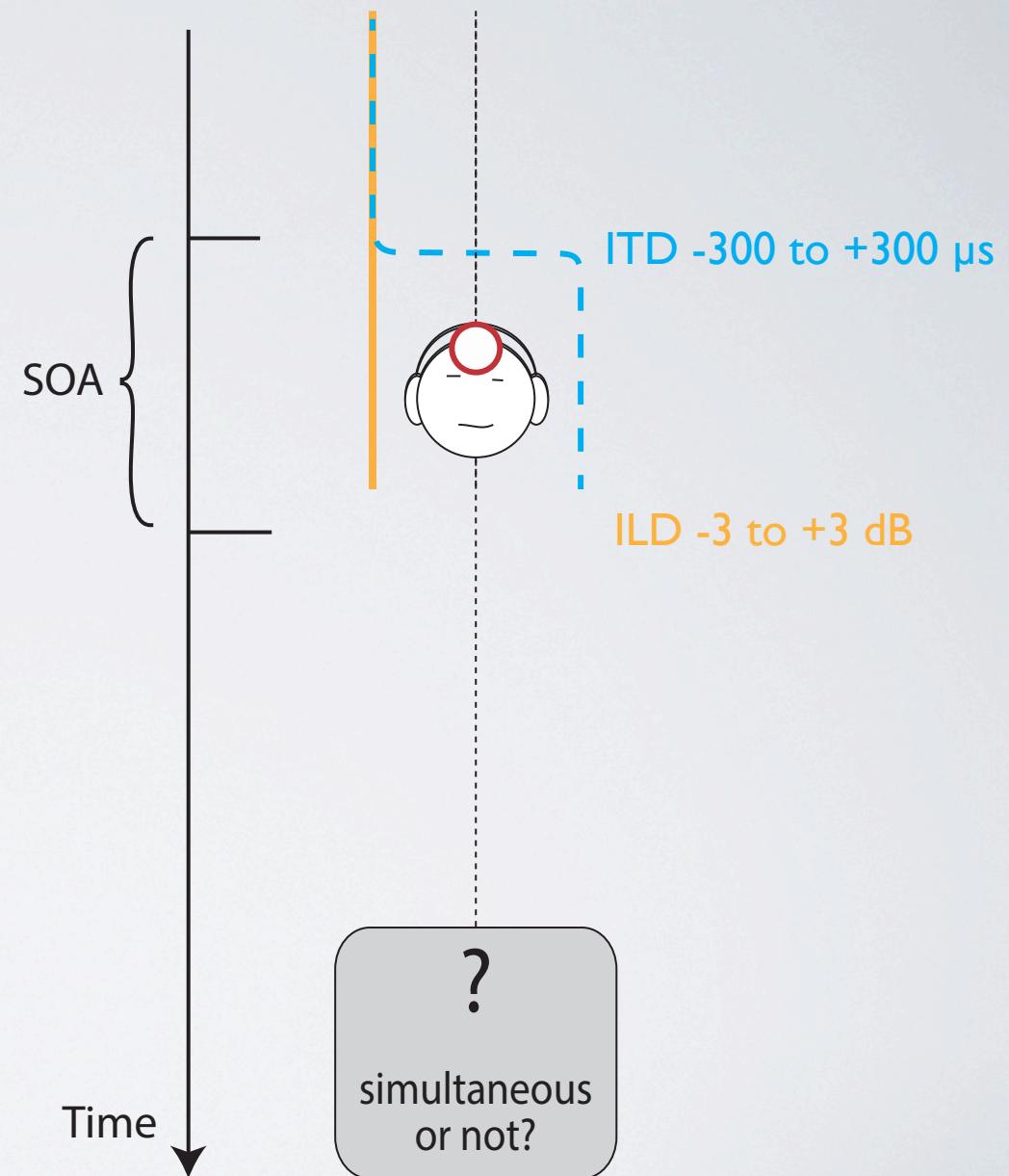
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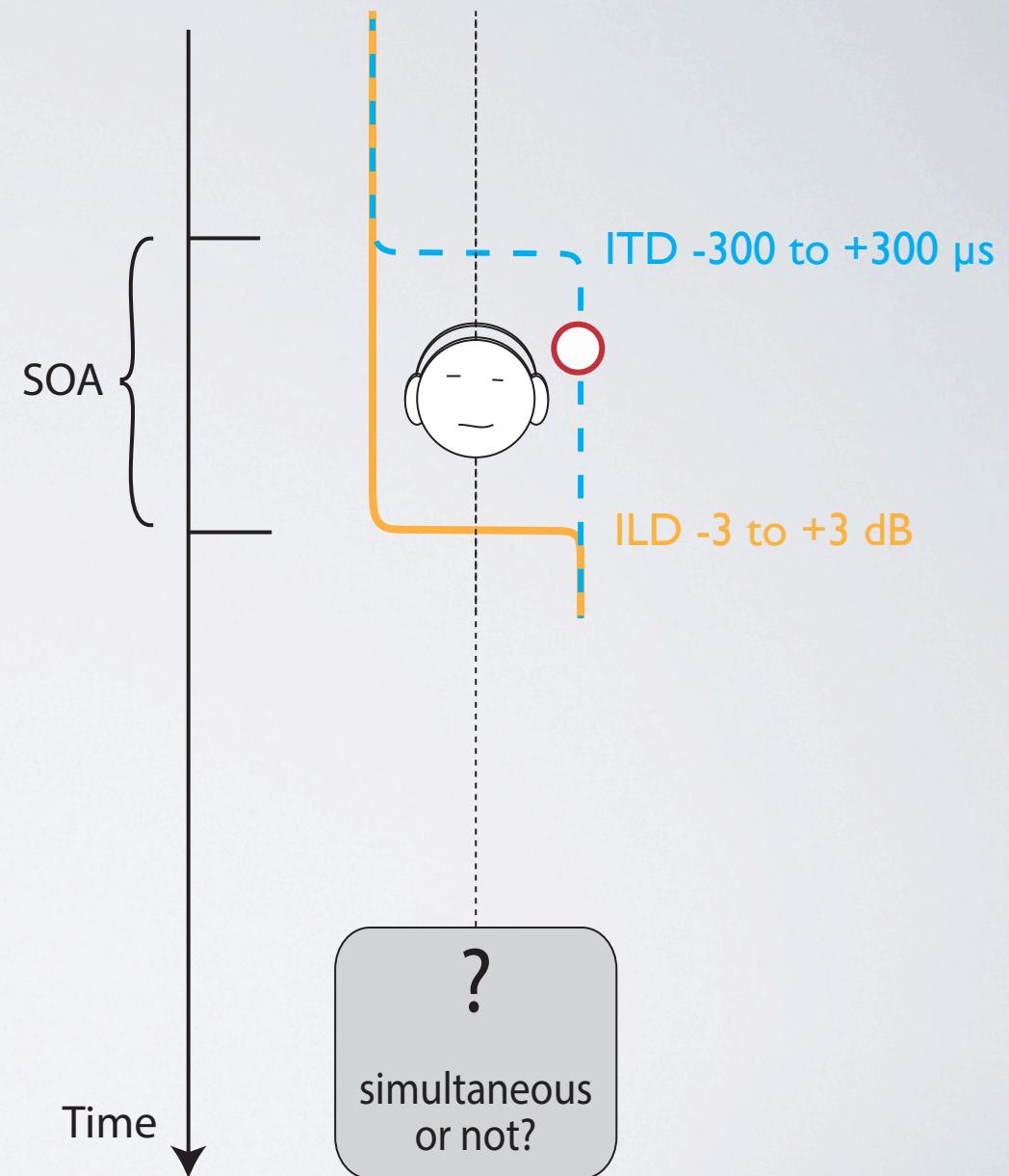
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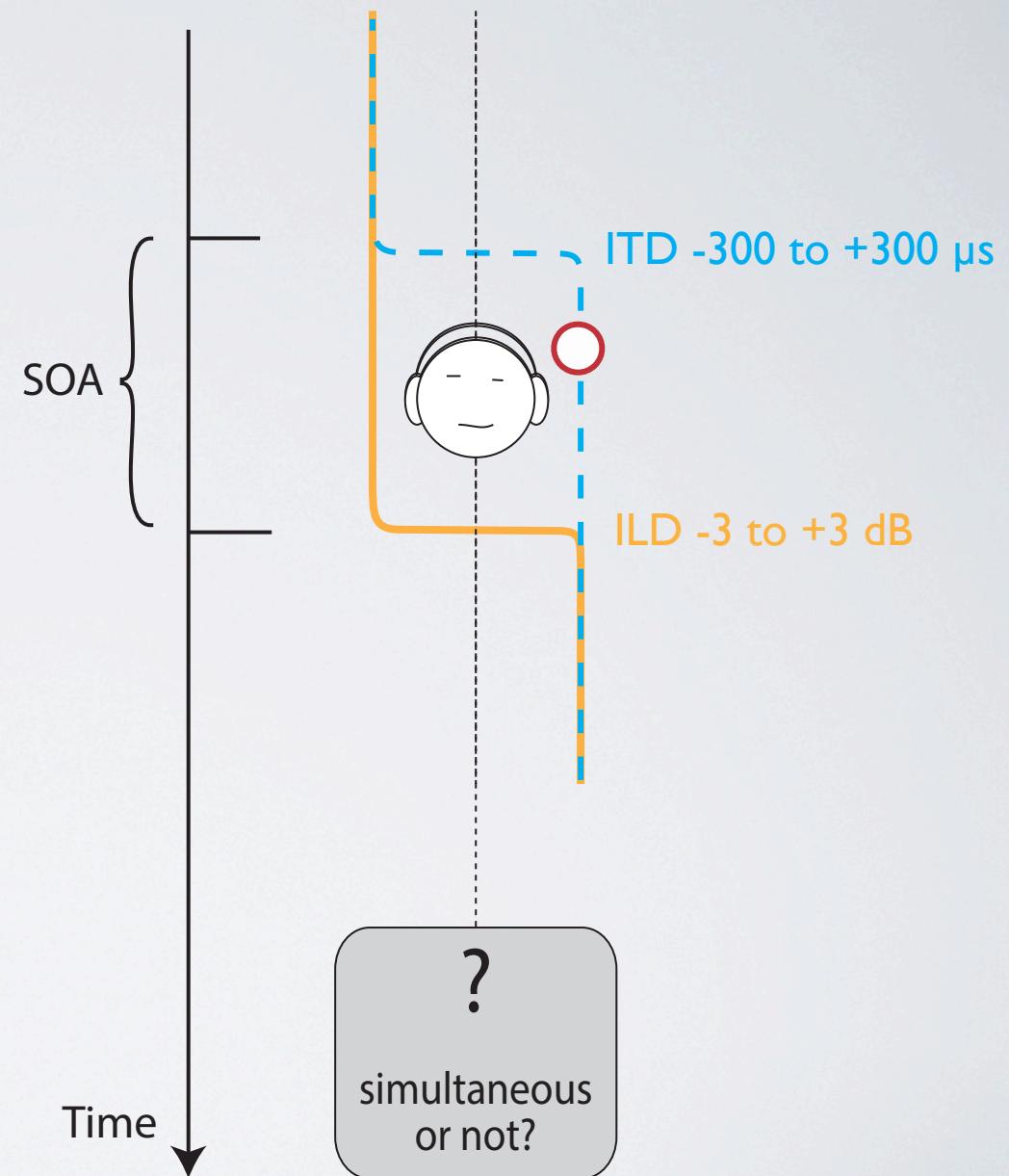
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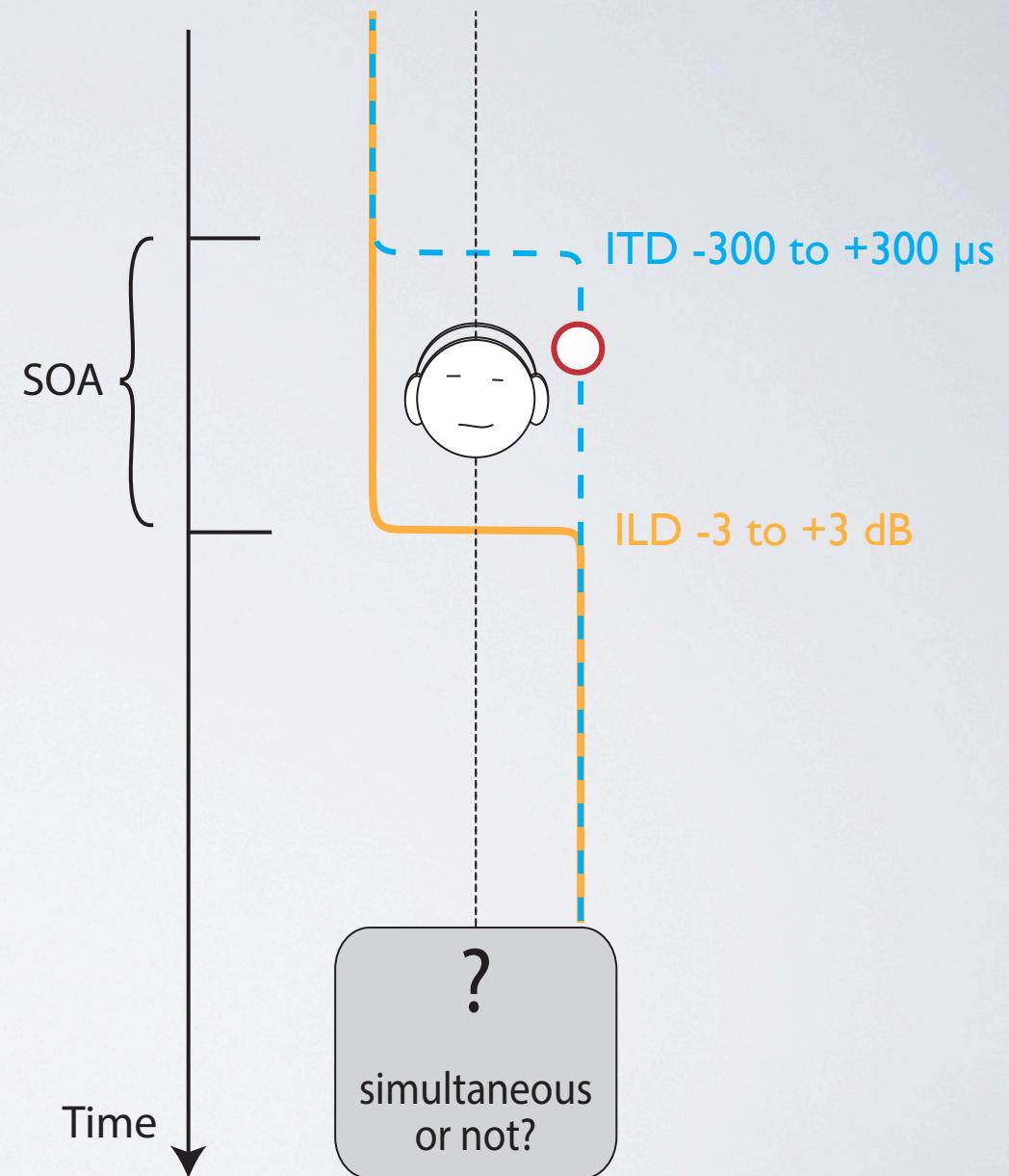
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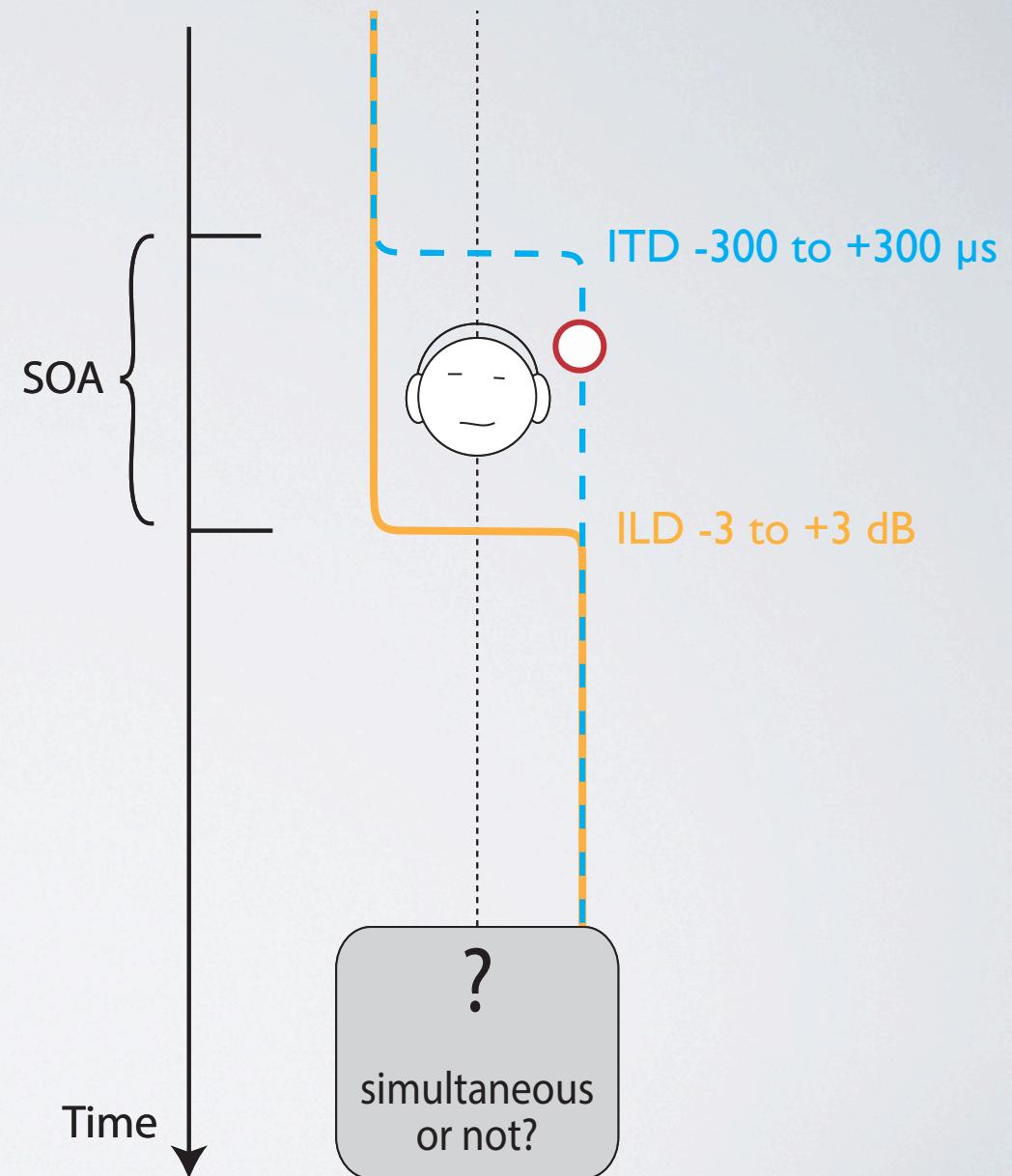
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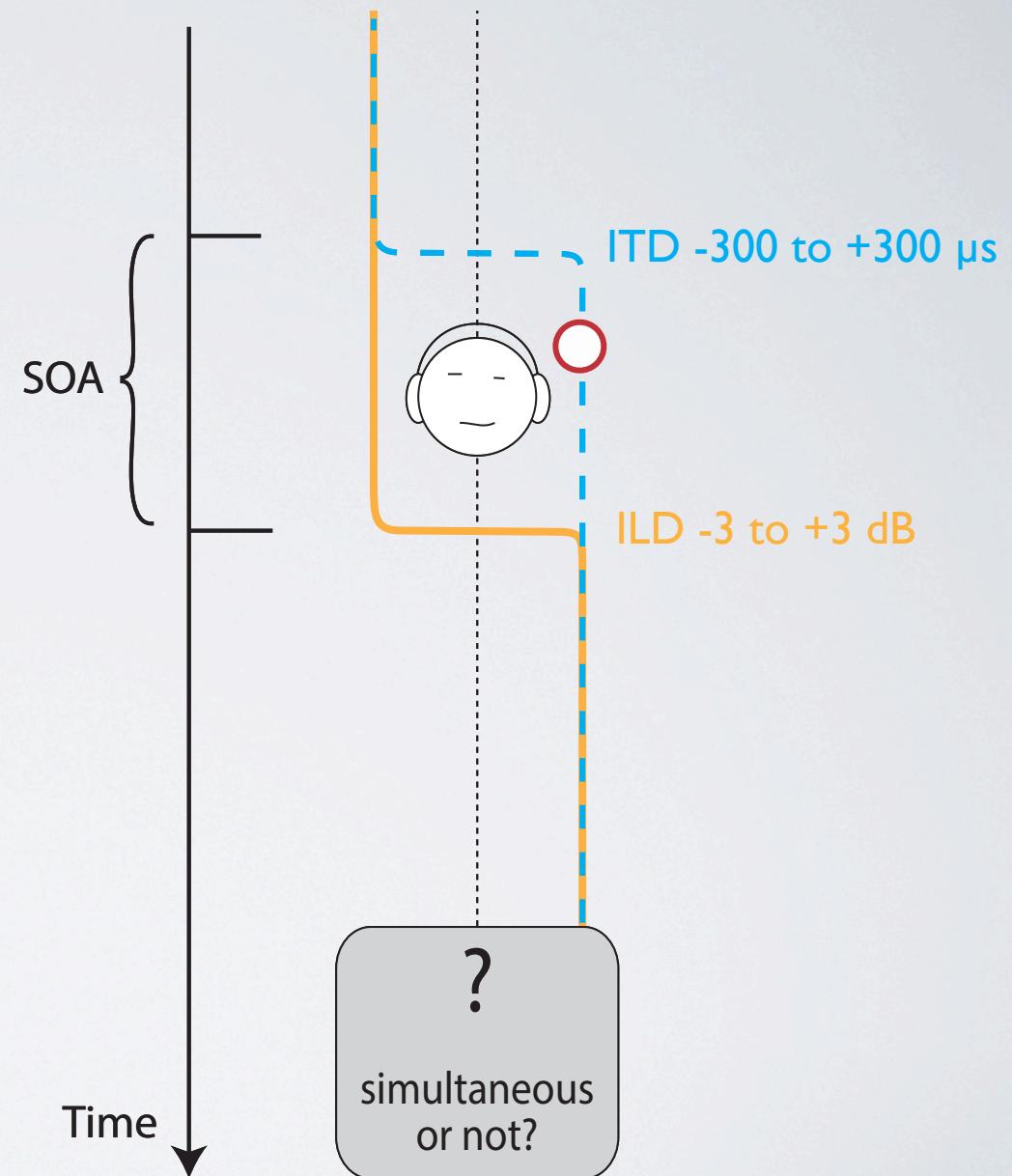
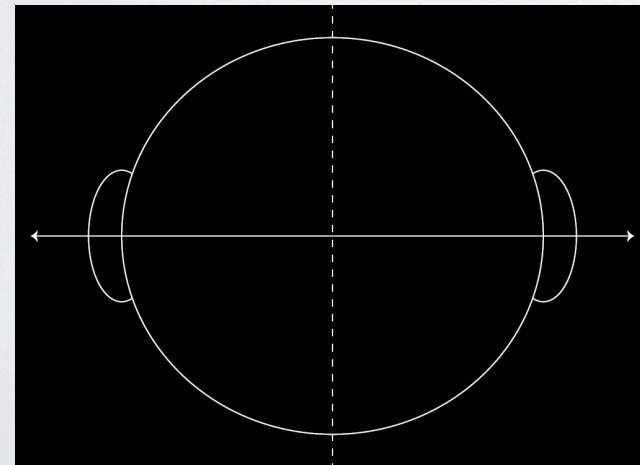
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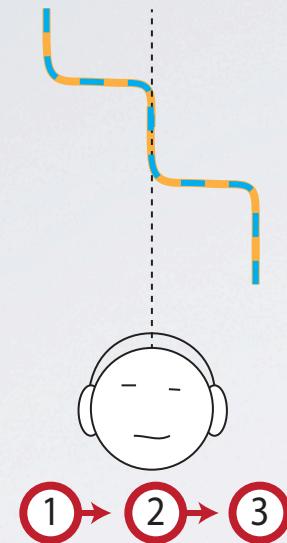


# Simultaneity perception in binaural integration?



# Simultaneity perception in binaural integration?

Segregated Percept



SOA

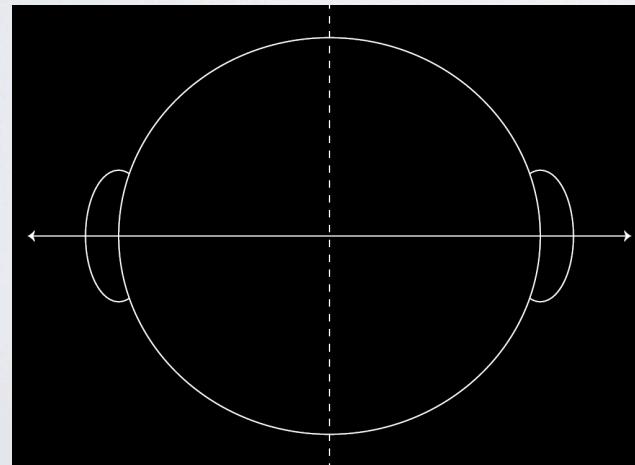
Time

ITD -300 to +300  $\mu$ s

ILD -3 to +3 dB

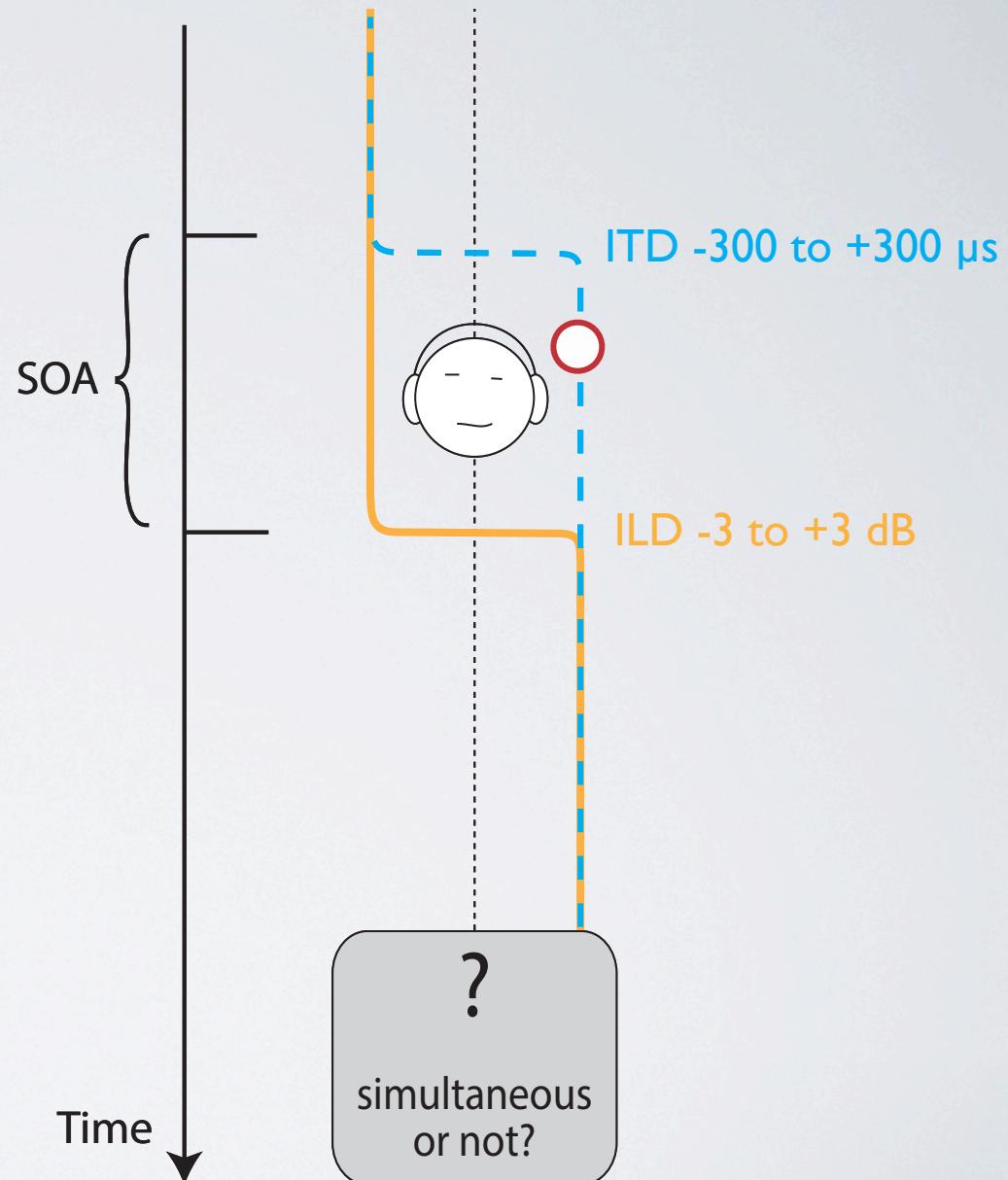
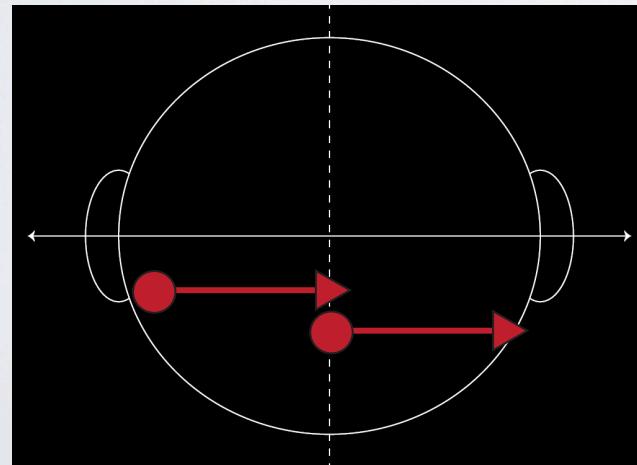
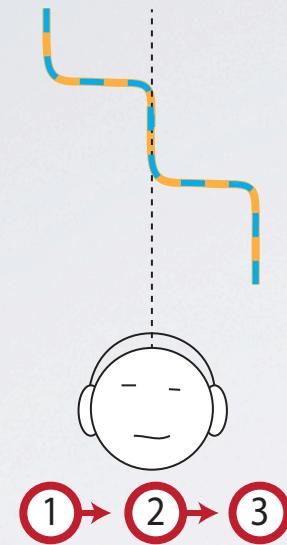
?

simultaneous  
or not?



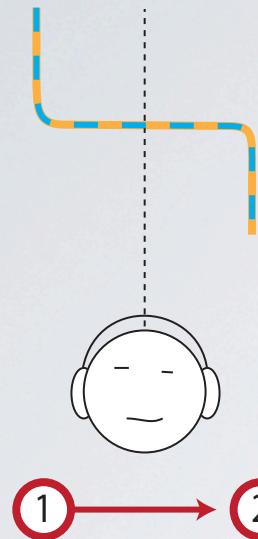
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Segregated Percept

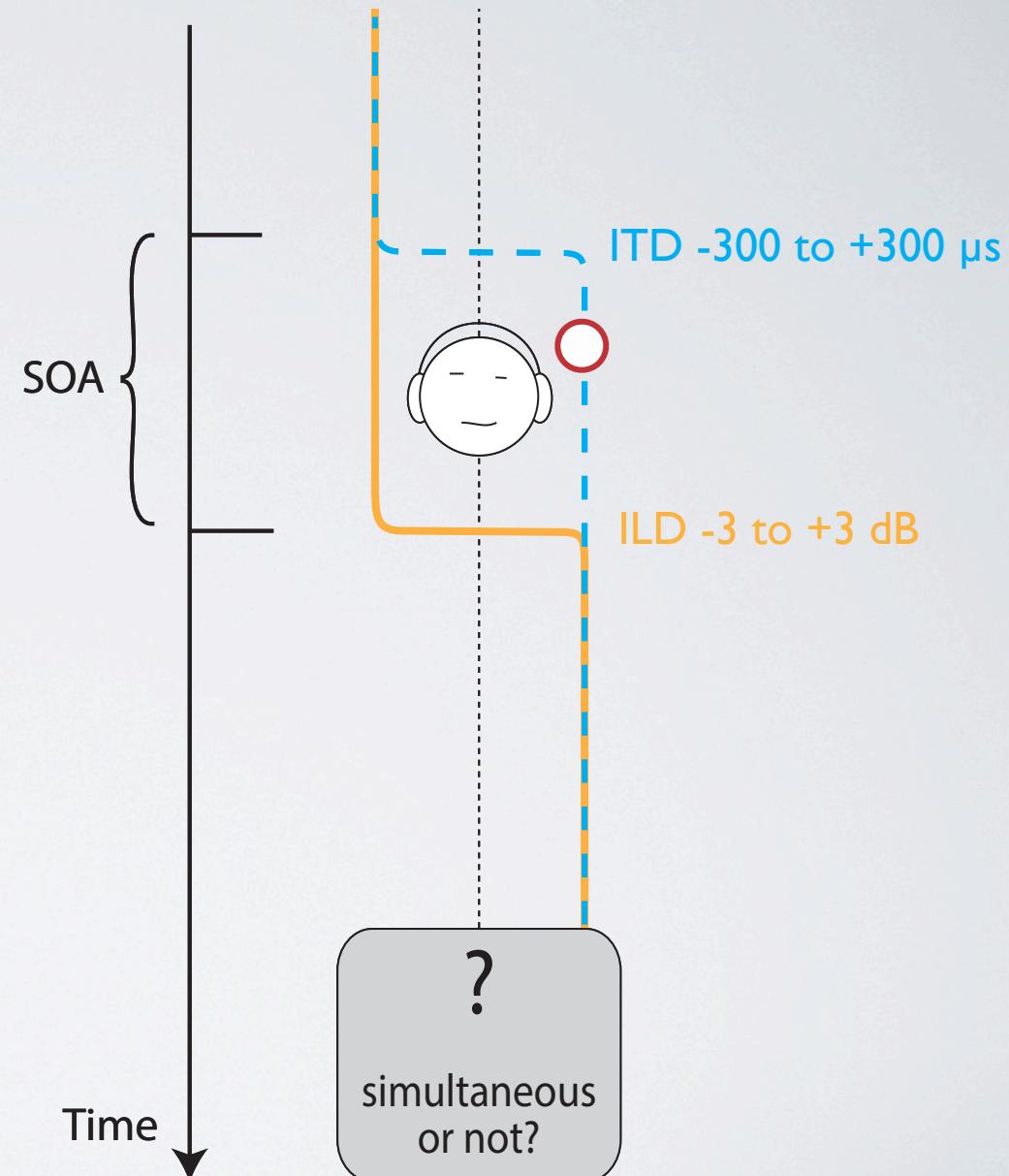
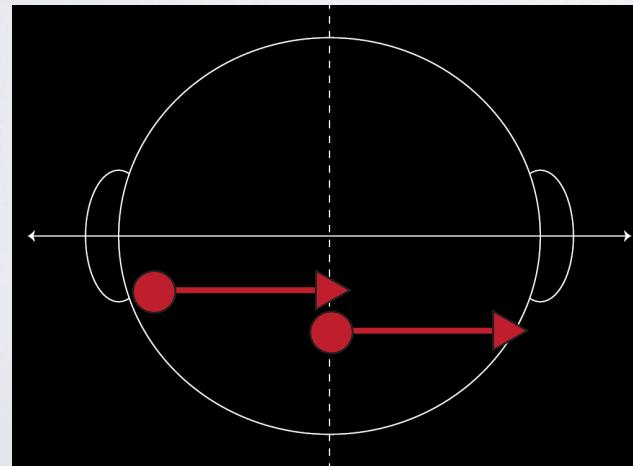
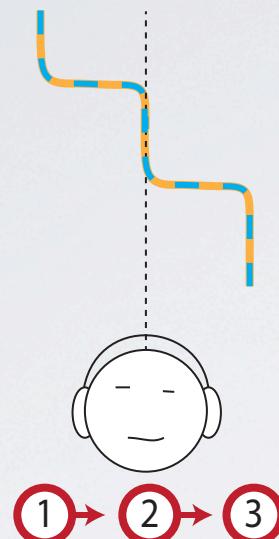


# Simultaneity perception in binaural integration?

Integrated Percept

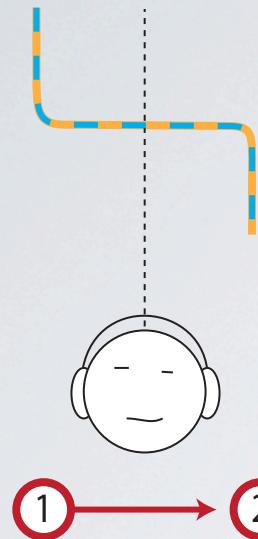


Segregated Percept

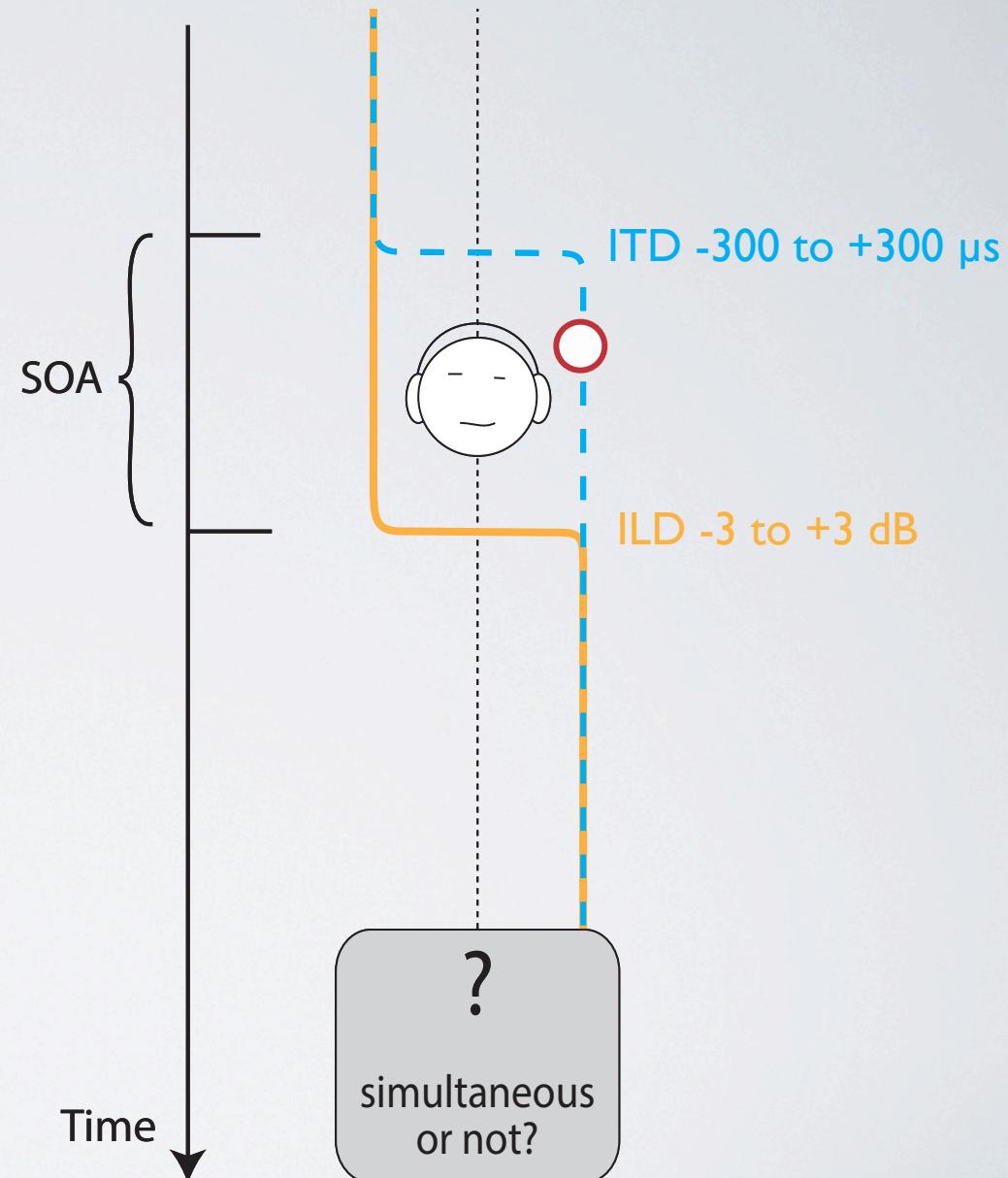
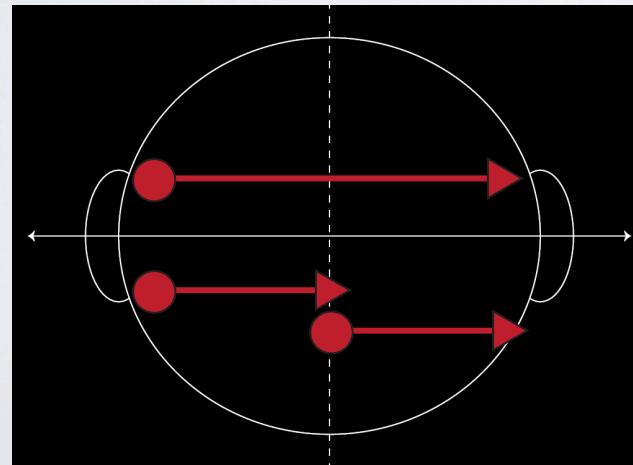
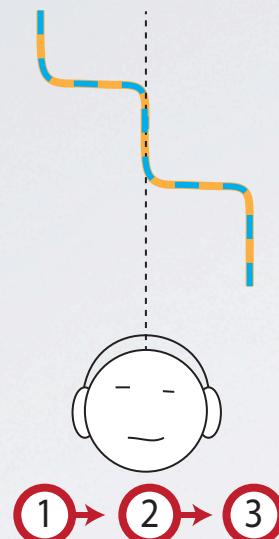


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Integrated Percept

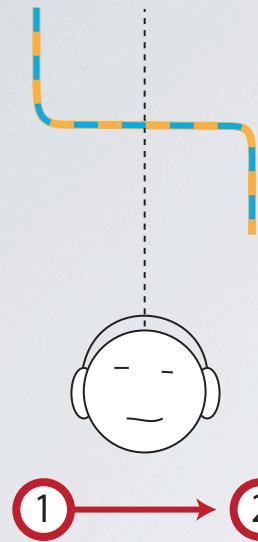


Segregated Percept

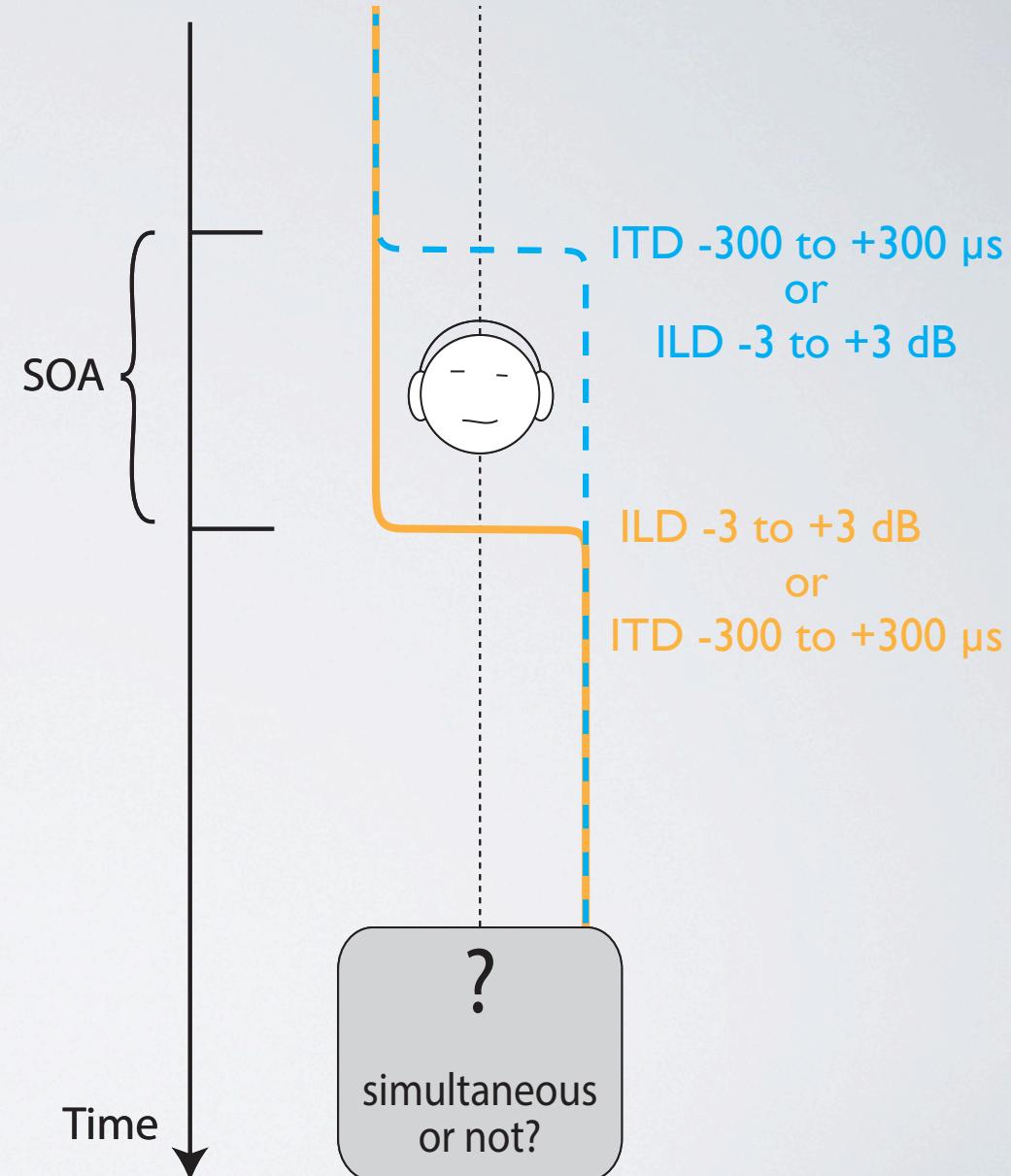
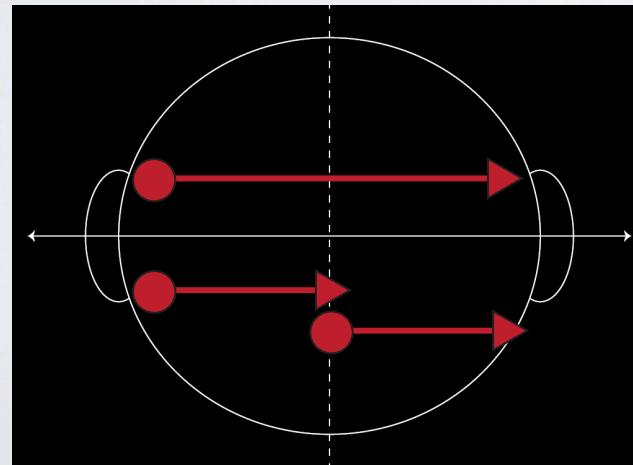
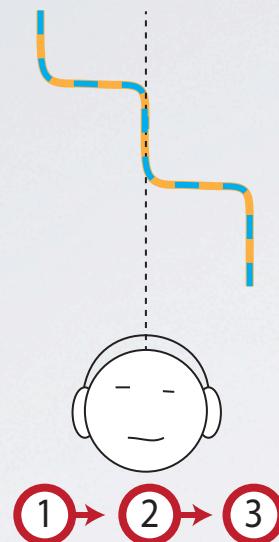


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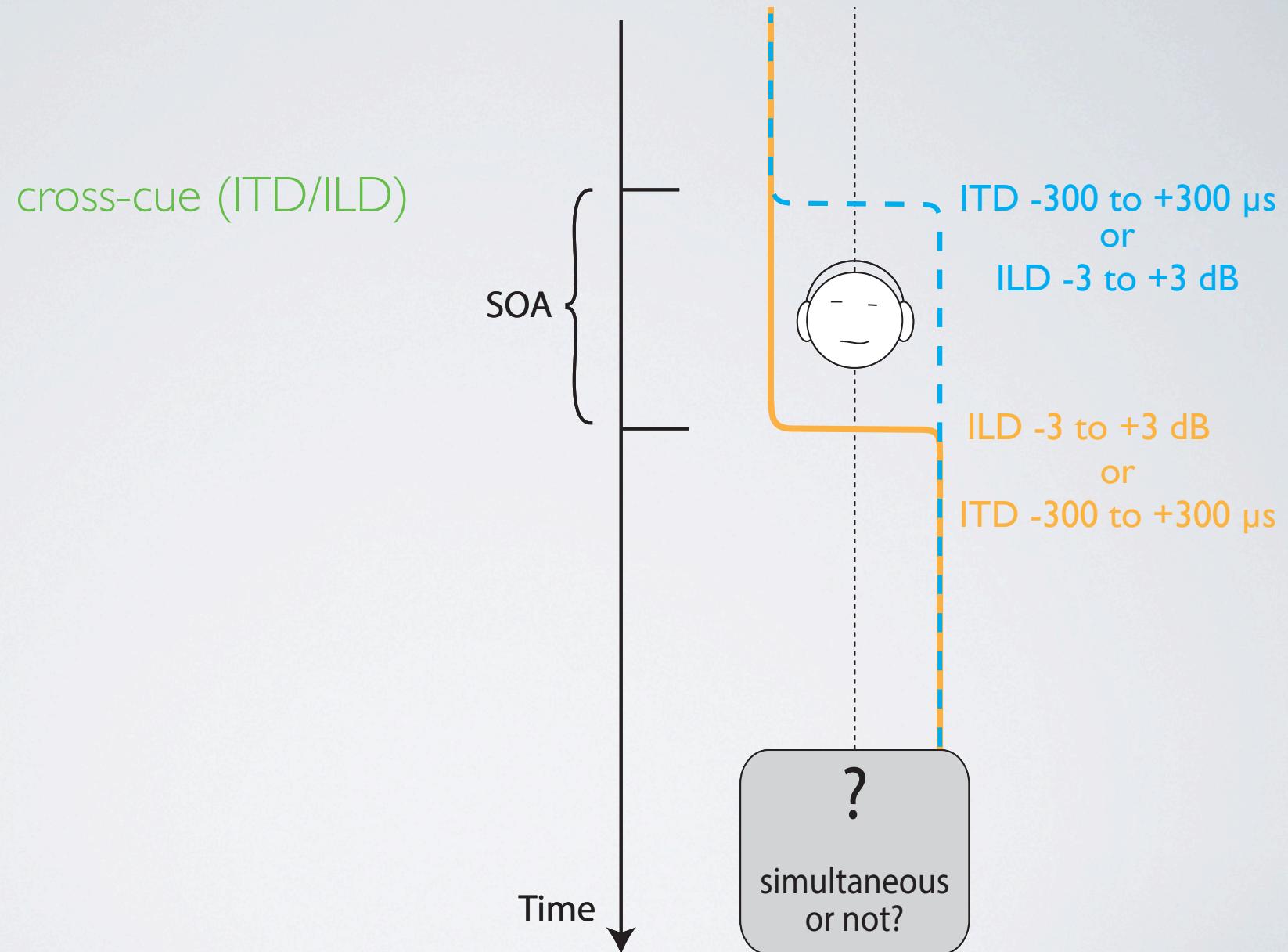
Integrated Percept



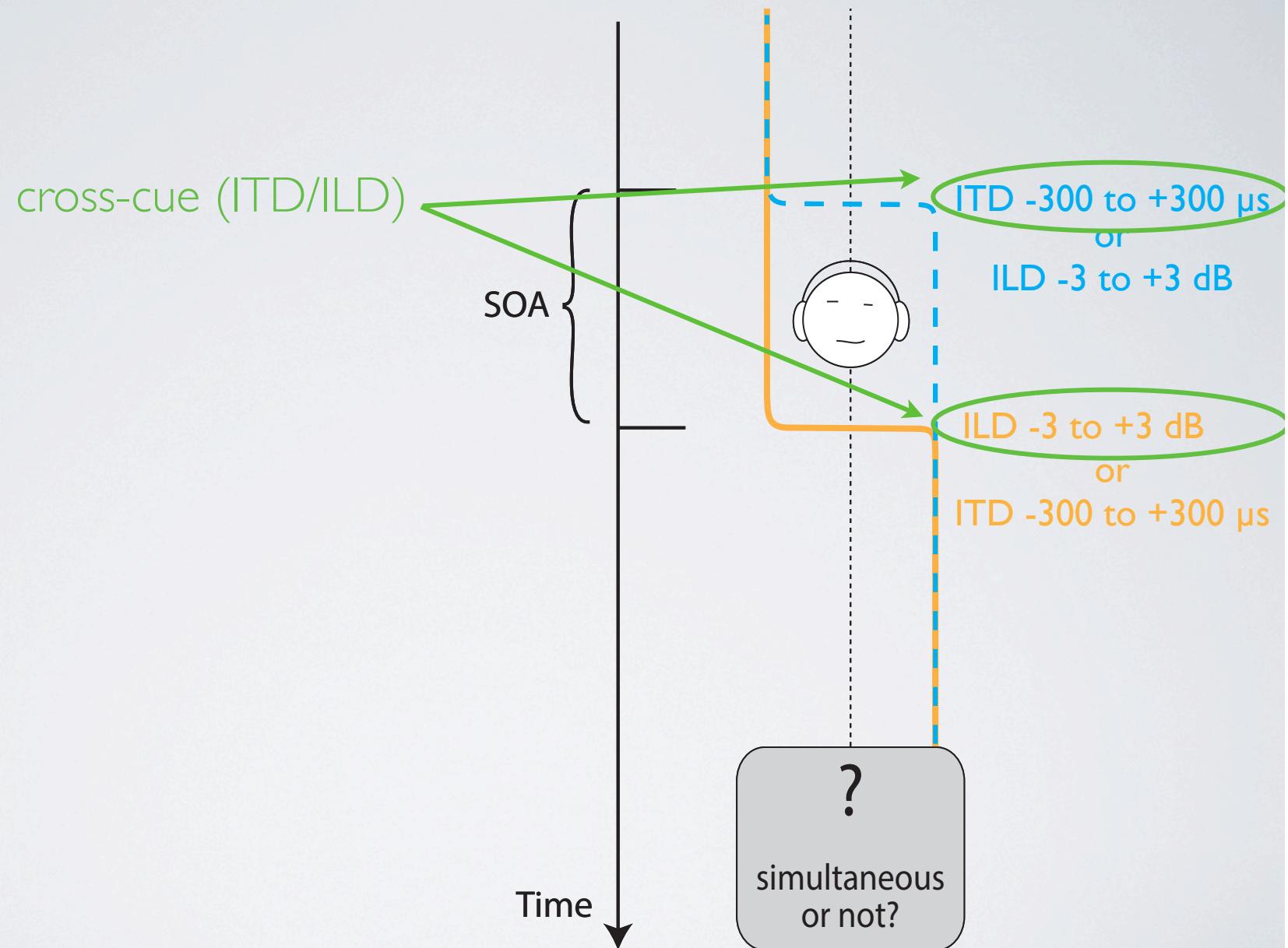
Segregated Percept



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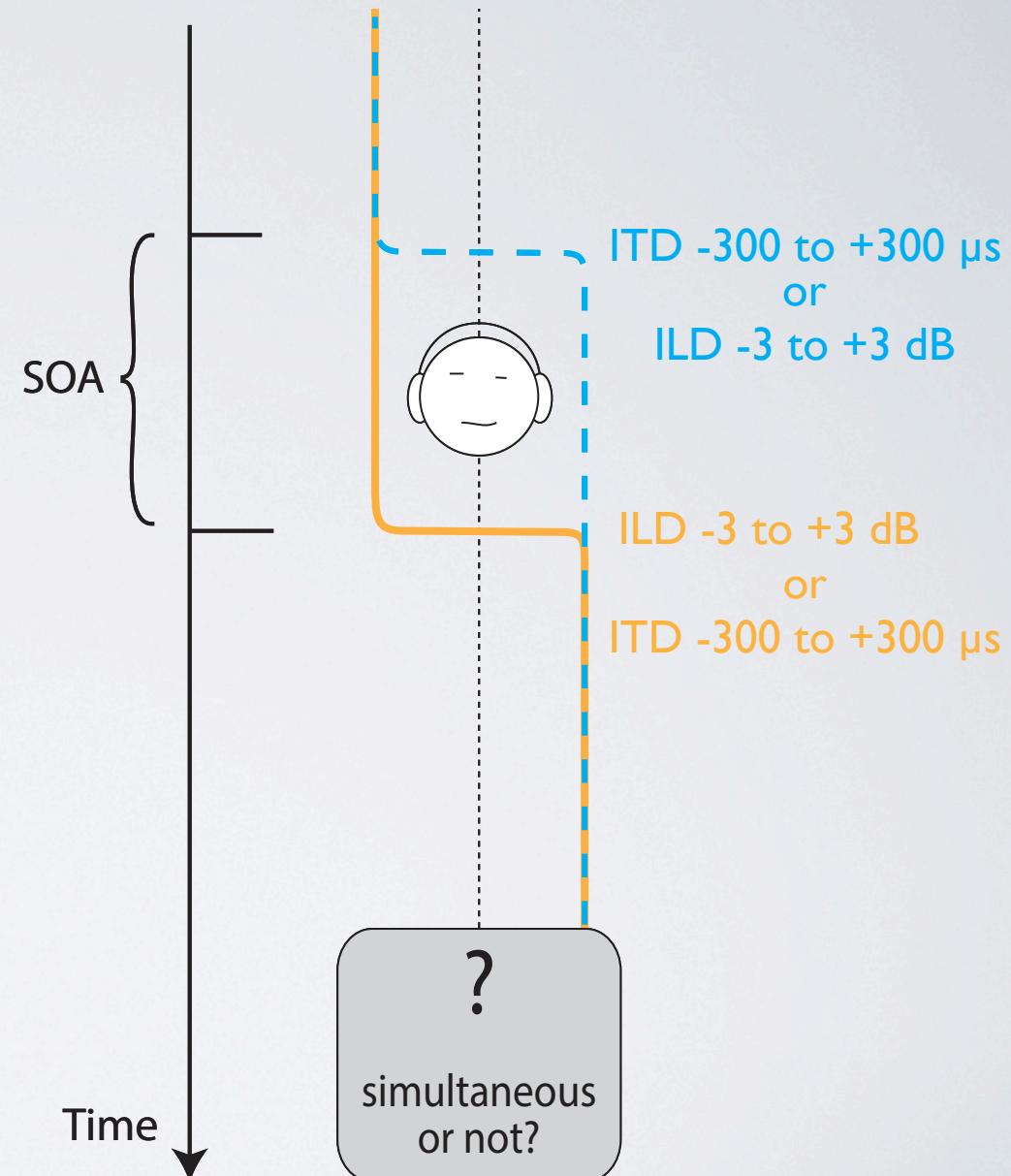
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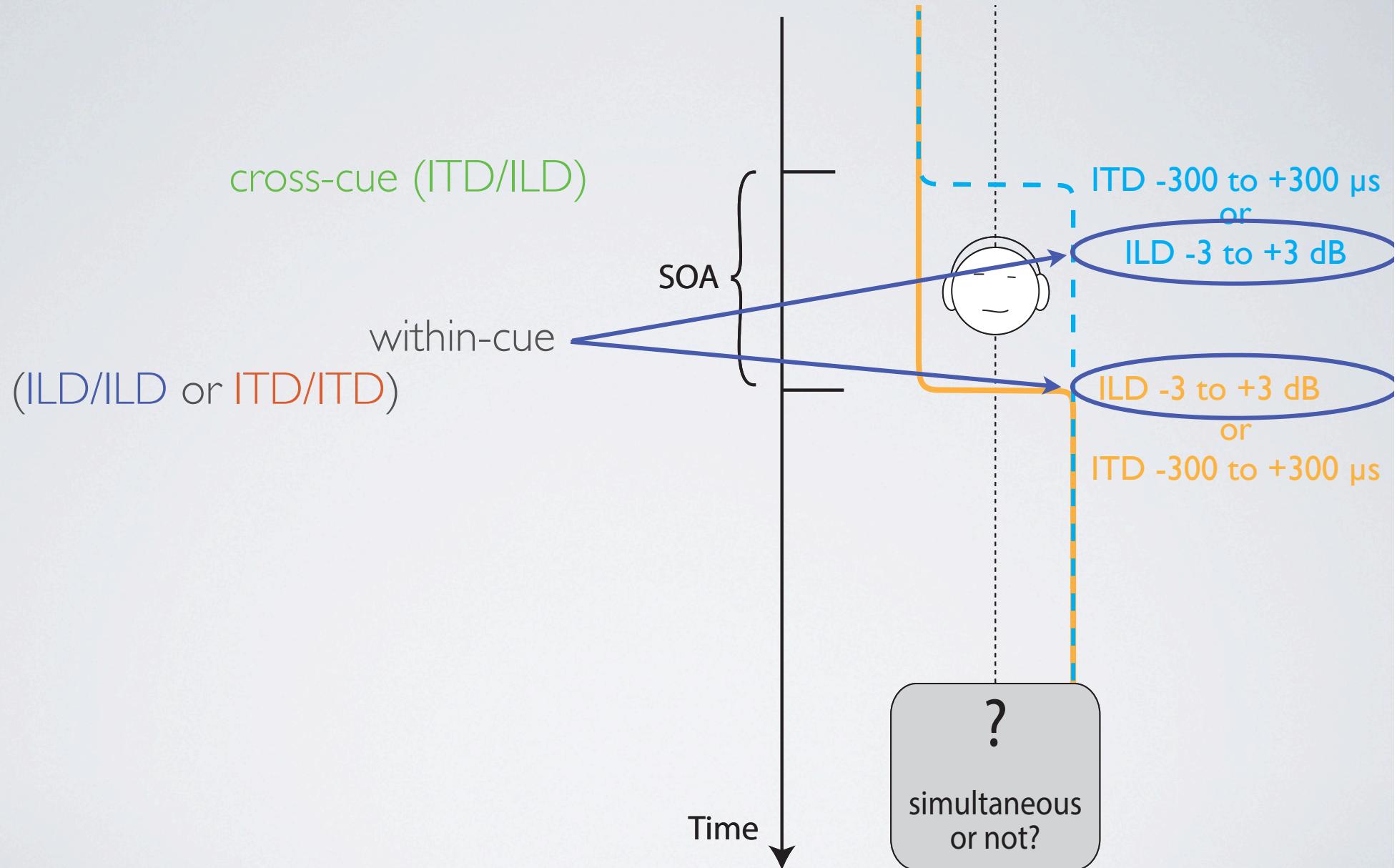
# Simultaneity perception in binaural integration?

cross-cue (ITD/ILD)

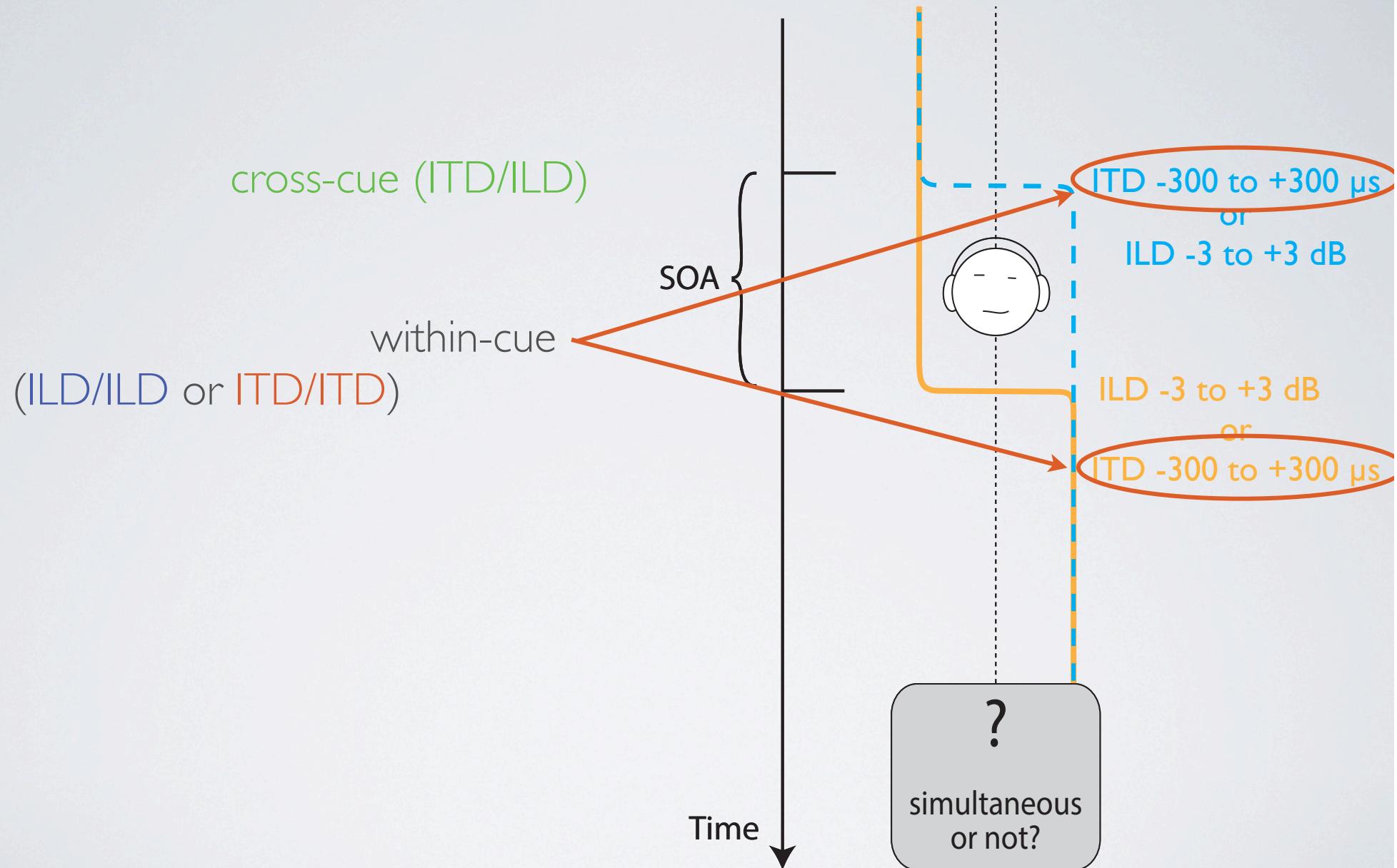
within-cue  
(ILD/ILD or ITD/ITD)



# Simultaneity perception in binaural integration?

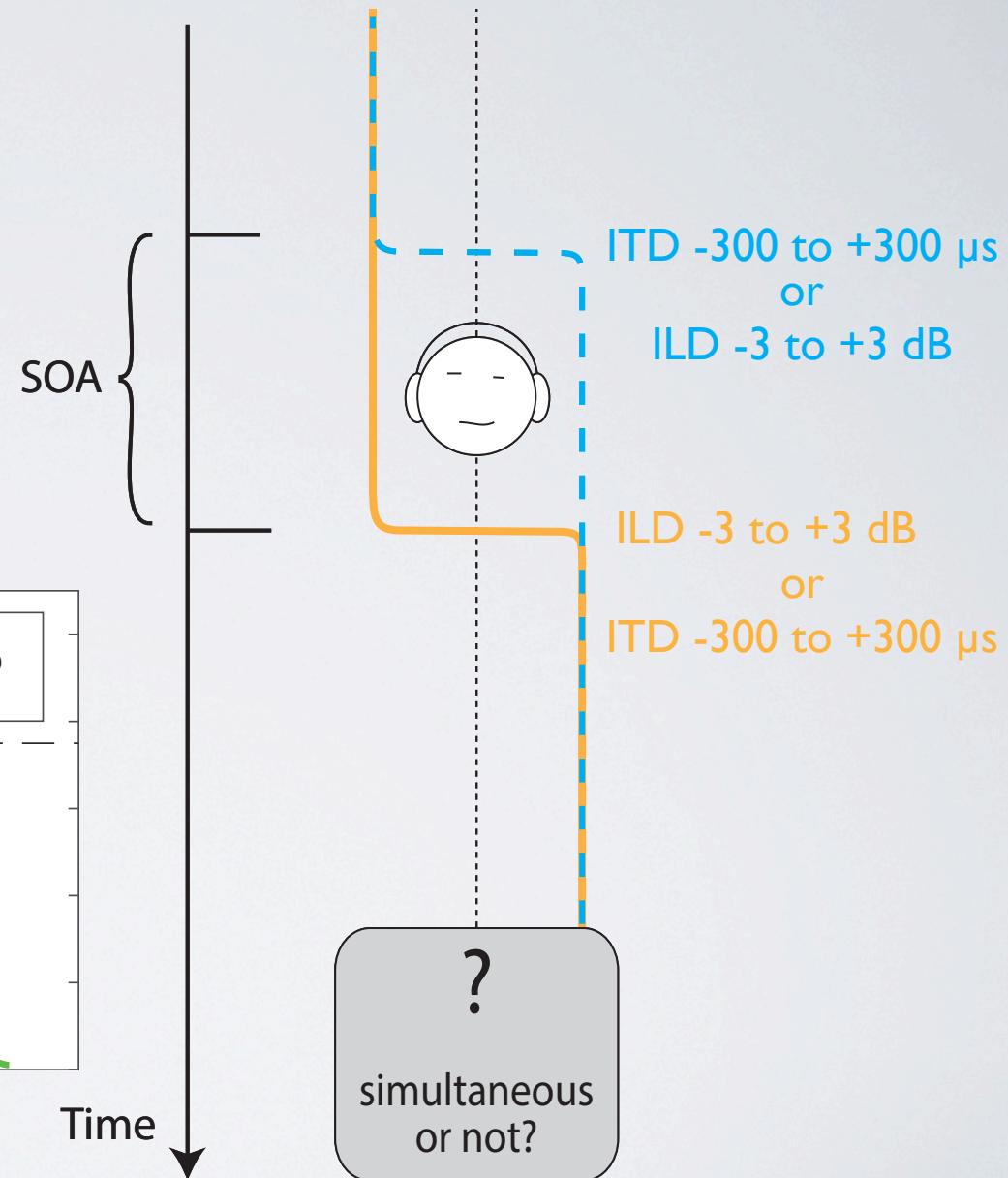
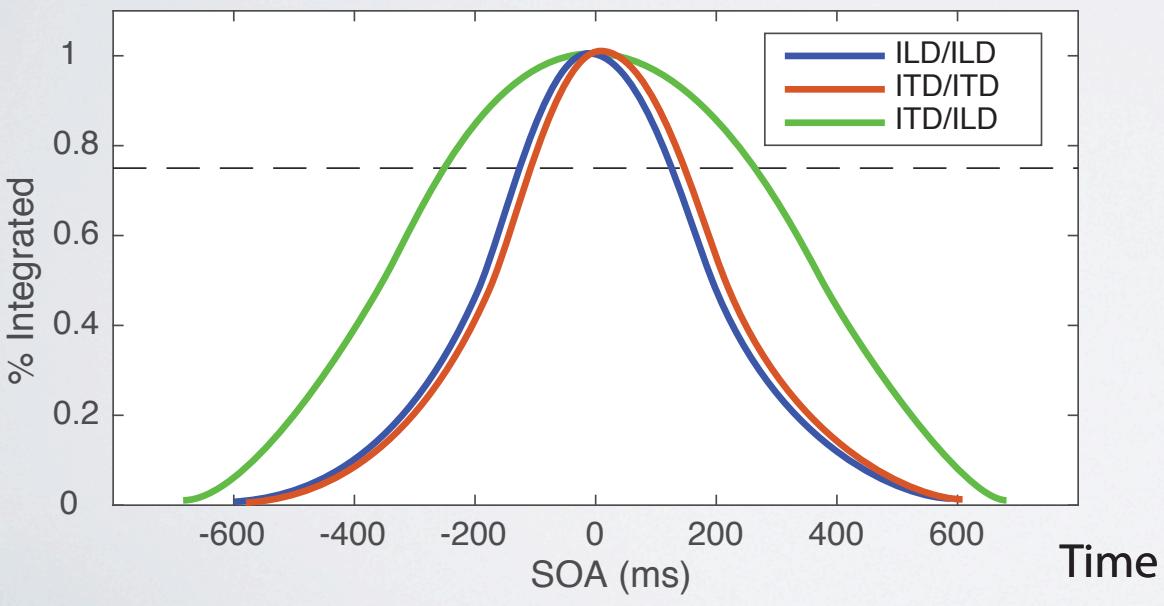


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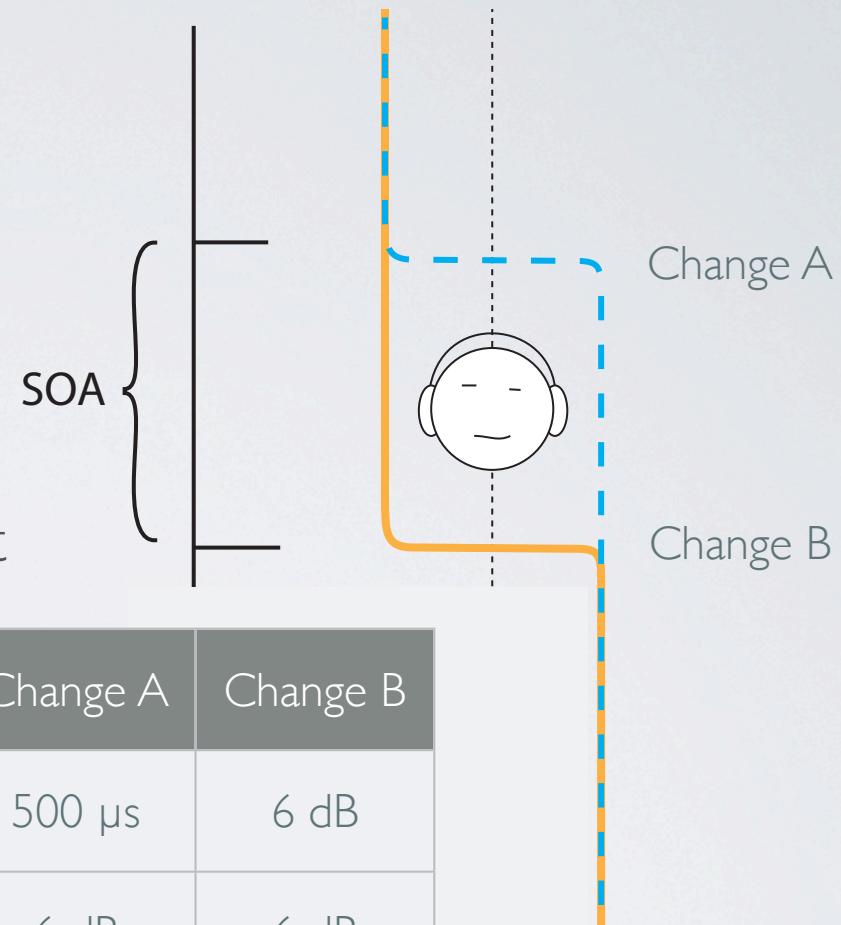
# Simultaneity perception in binaural integration?

- Hypothesis: longer integration window for cross-cue (ITD/ILD) comparison (late integration).
- Shorter window to within-cue (ILD/ILD or ITD/ITD) comparison.



# Methodological details

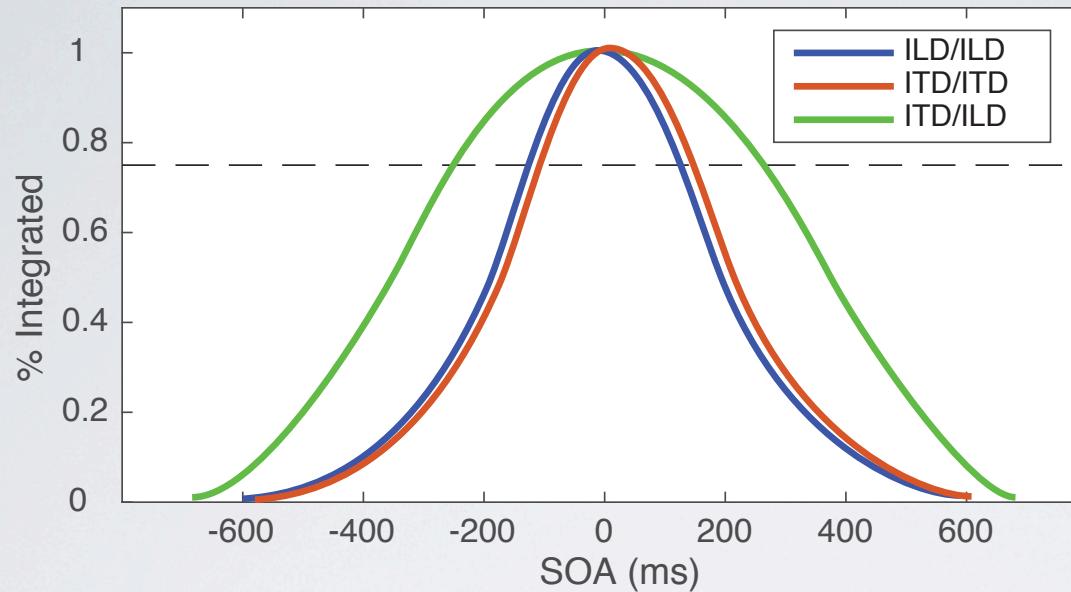
- One-octave noise band, center frequency: 500 Hz. Dur: 2 seconds
- “Change A” time  $1 \pm 0.2$
- SOA ranged -600 ms to +600 ms
- Changes left-to-right or right-to-left



Conditions		start	Change A	Change B
	Cross-cue (ITD/ILD)	250 $\mu$ s / 3 dB	500 $\mu$ s	6 dB
	ILD/ILD	0 $\mu$ s / 6 dB	6 dB	6 dB
	ITD/ITD	500 $\mu$ s / 0 dB	500 $\mu$ s	500 $\mu$ s

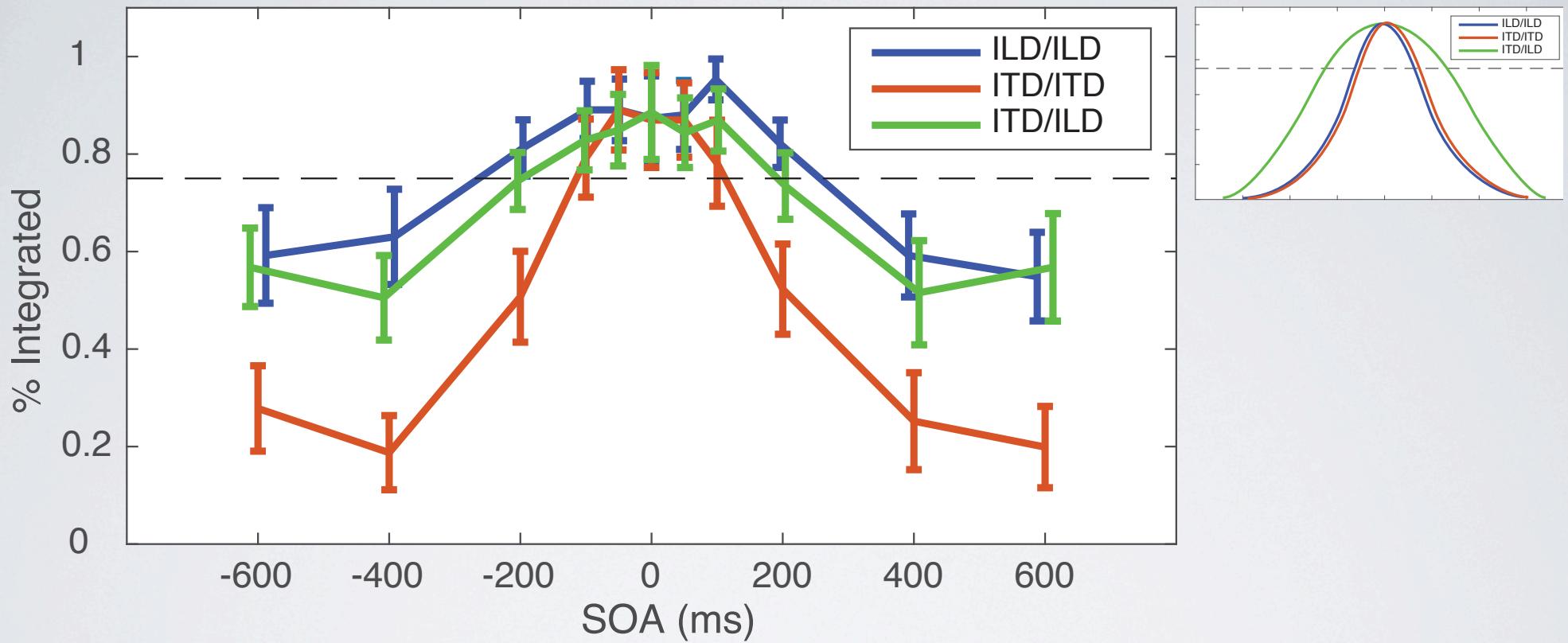
- Subjects “drew” each change; we analyzed number of changes reported

# The hypothesis (a reminder)



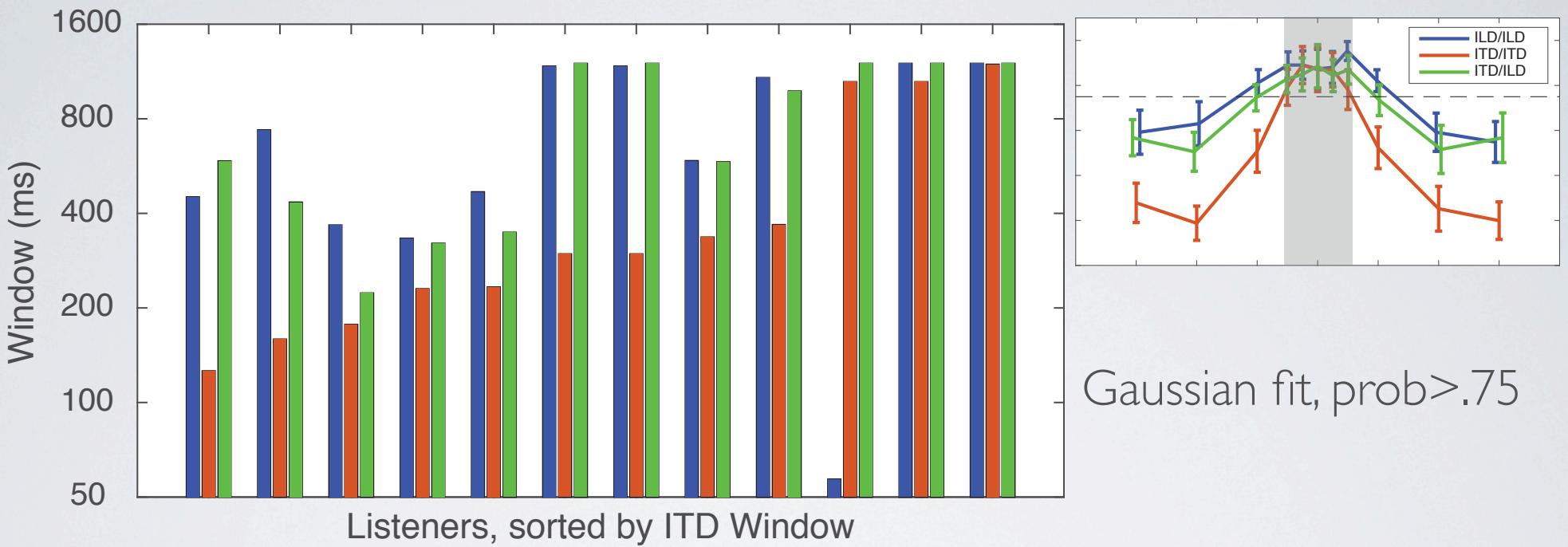
		start	Change A	Change B
Conditions	Cross-cue (ITD/ILD)	250 $\mu$ s / 3 dB	500 $\mu$ s	6 dB
	ILD/ILD	0 $\mu$ s / 6 dB	6 dB	6 dB
	ITD/ITD	500 $\mu$ s / 0 dB	500 $\mu$ s	500 $\mu$ s

# Results: briefer integration window for ITD than for ILD or cross-cue judgments

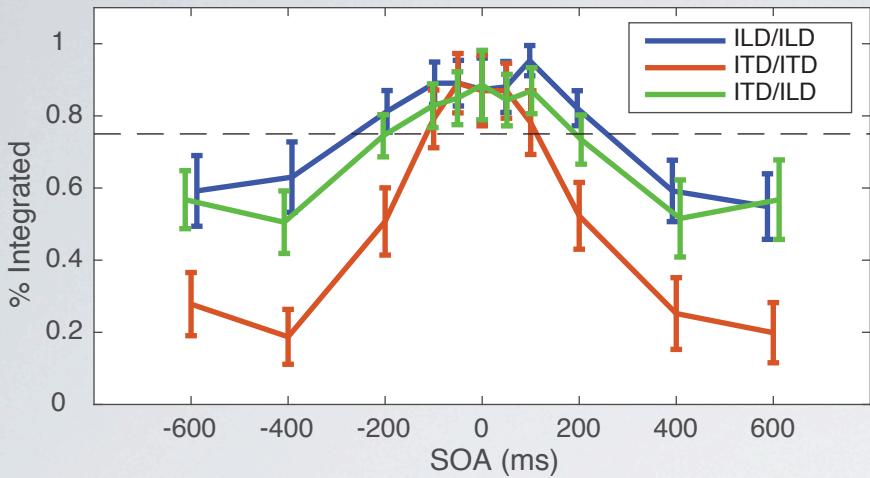


- No support for hypothesis. Cross-cue window  $\leq$  ILD window
- Better temporal fidelity for ITD comparisons

# Results: briefer integration window for ITD than for ILD or cross-cue judgments



- Some listeners exhibited extremely broad windows when ILD was a cue
- Possible tendency to perceive smooth (but slower) motion?



## Some conclusions

- Narrow temporal window for ITD/ITD, broad for ILD/ILD
- Cross-cue window appears dominated by ILD (cf. multisensory)

Consistent with ideas about integrative ILD / differentiative ITD processing (e.g. Remme et al. 2014; Brown & Stecker 2010; Stecker et al. 2013)

- May be consistent with late-stage ILD computation / recency effects (Stecker & Hafter 2009)

Thank you