

# SENSORY-MOTOR ADAPTATION IS (MOSTLY) LINEAR

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\*starting June, 2015:

NYU Langone Medical Center  
Departments of Neurology and  
Rehabilitation Medicine

Wednesday, May 20, 15

## Sensory-Motor Adaptation

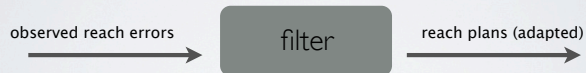
- Serves to reduce errors when the sensory-motor loop is perturbed (e.g., when prism-glasses are worn)
  - That is, it maintains the mapping between desired and actual movement outcomes.
- This maintenance of the input/output mapping can be thought of as a filter:



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- This maintenance of the input/output mapping can be thought of as a filter:



- When considering filter performance, the first question we typically ask is: *Is it linear?*

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## Linearity

A linear system displays superposition:

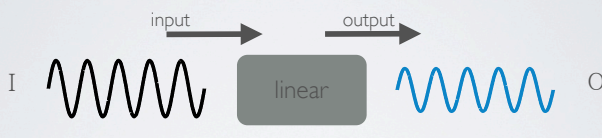
- Homogeneity
- Additivity

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## Linearity

A linear system displays superposition:

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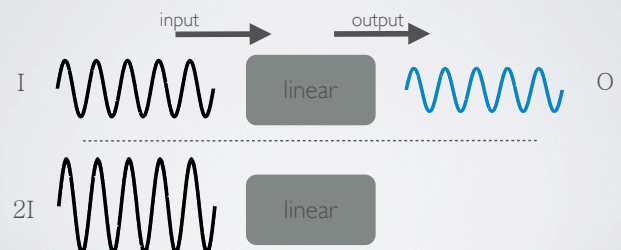


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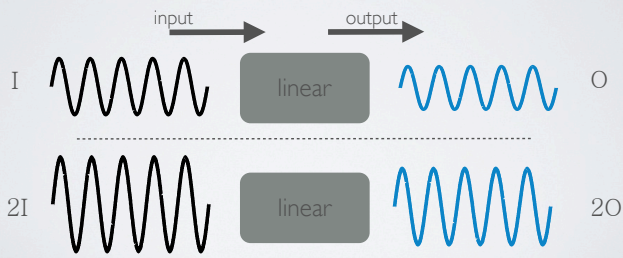


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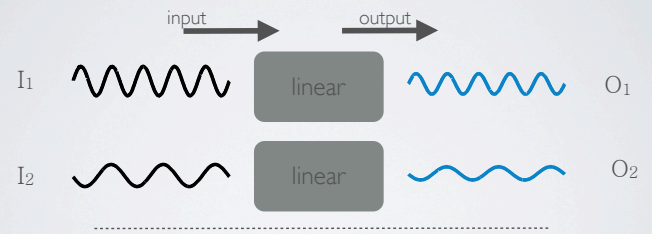


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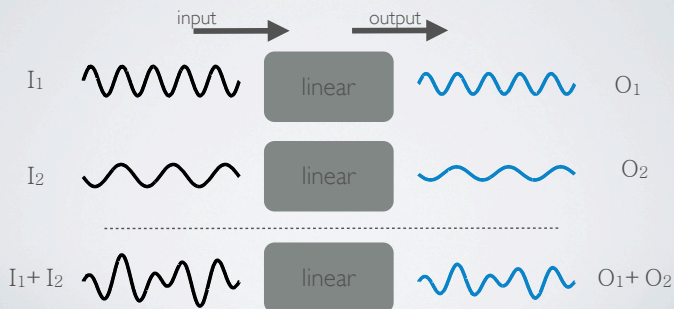


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## Linearity

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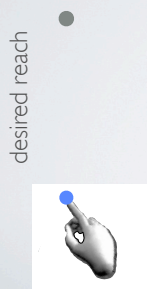
## Experimental Considerations

- 1) Size of perturbation
- 2) Coordinate system

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## Experimental Considerations

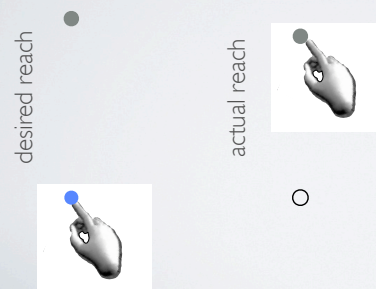
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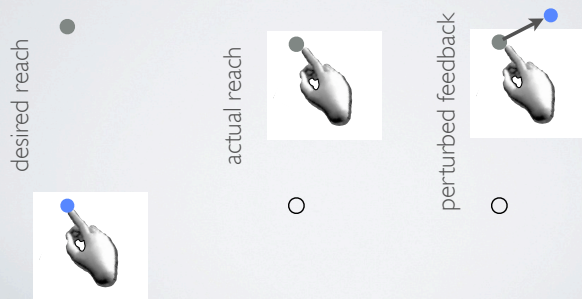
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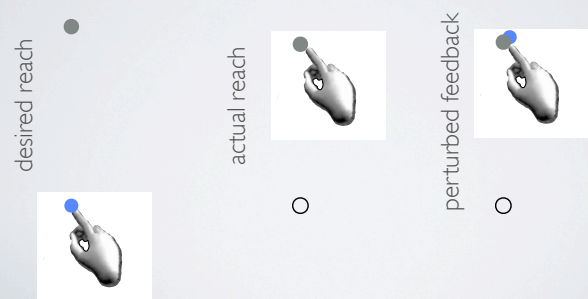
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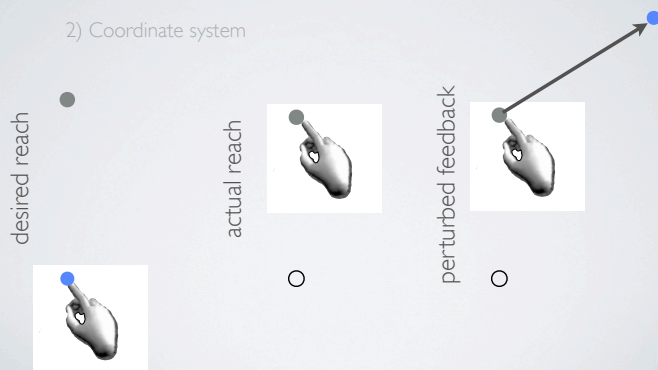
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correction of perturbation from a previous movement

- active correction [i.e., conscious correction]
- automatic correction [i.e., adaptation]

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correction of perturbation from a previous movement

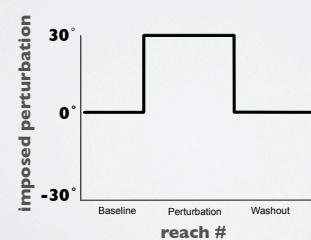
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typical adaptation paradigm



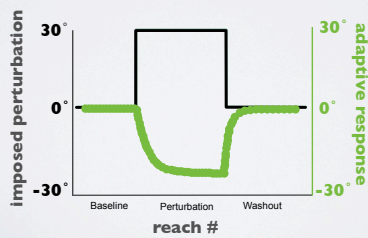
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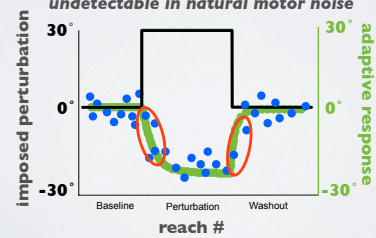
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typical adaptation paradigm

**if perturbation is not large, the adaptive response will be undetectable in natural motor noise**

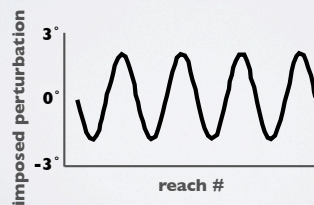


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sinewave-adaptation paradigm



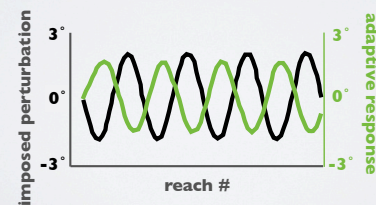
Hudson & Landy, 2012

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sinewave-adaptation paradigm



Hudson & Landy, 2012

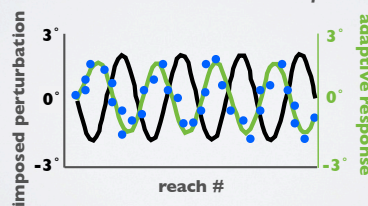
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sinewave-adaptation paradigm

**a detectable perturbation can be on the order of several degrees, because all data contribute to detection and estimation of sinewave parameters**



Hudson & Landy, 2012

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## Experimental Considerations

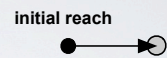
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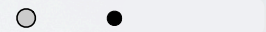
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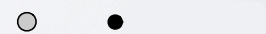
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**second reach: polar**



**second reach: Cartesian**



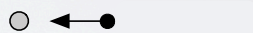
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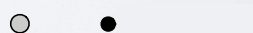
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**second reach: polar**



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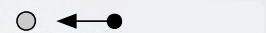
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**second reach: polar**



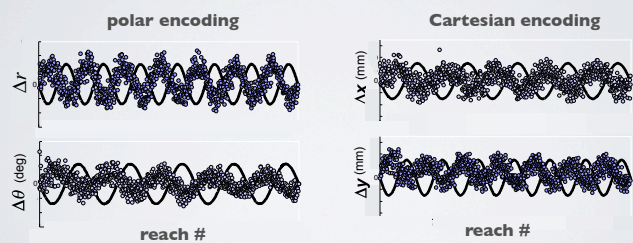
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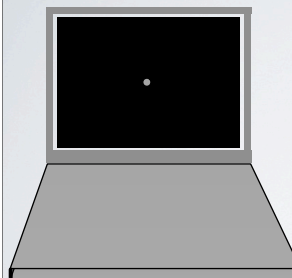
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Landy & Hudson, VSS 2012  
Hudson & Landy, under revision

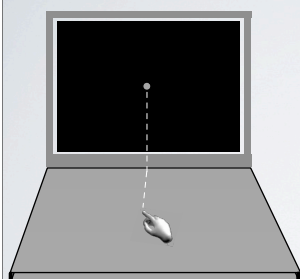
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## Method



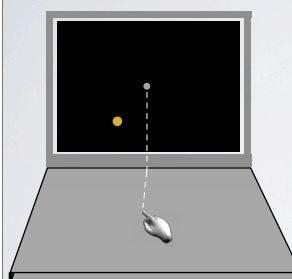
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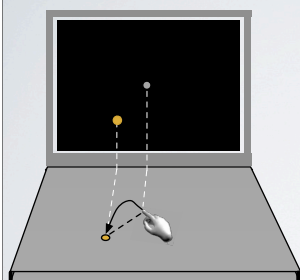
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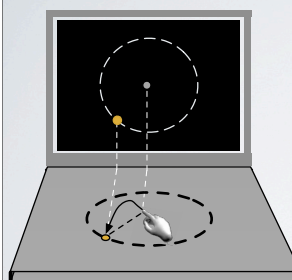
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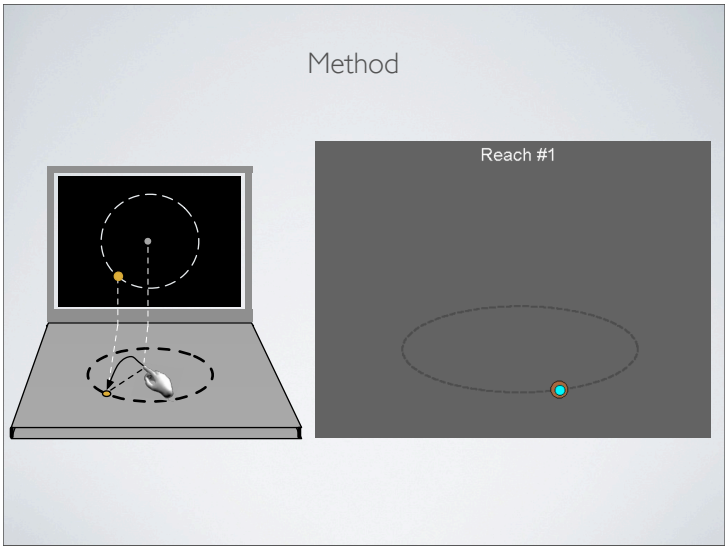
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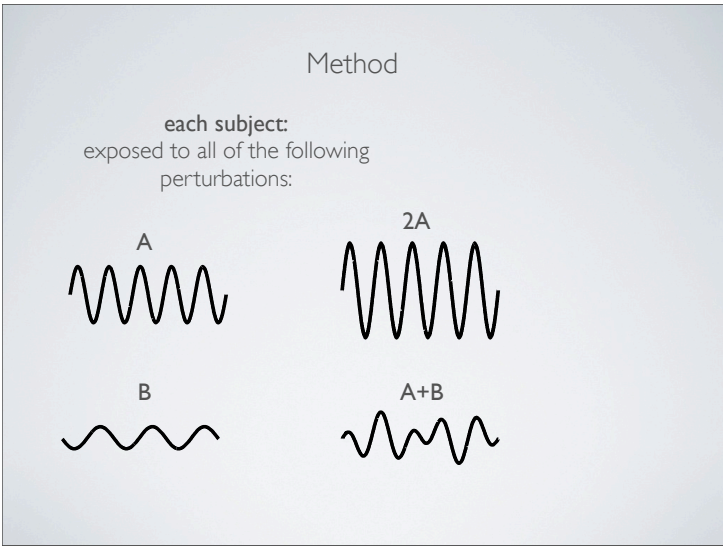


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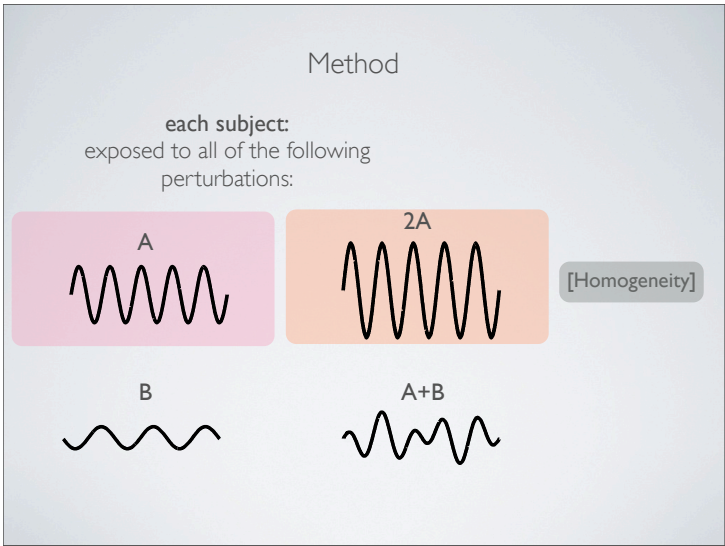




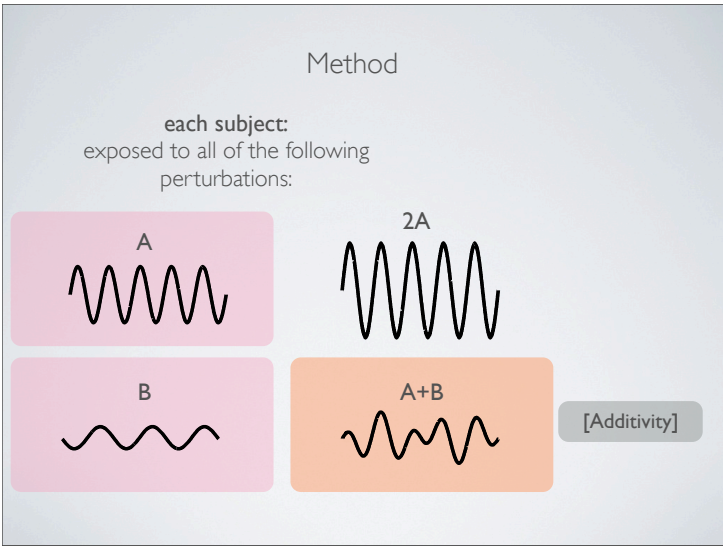
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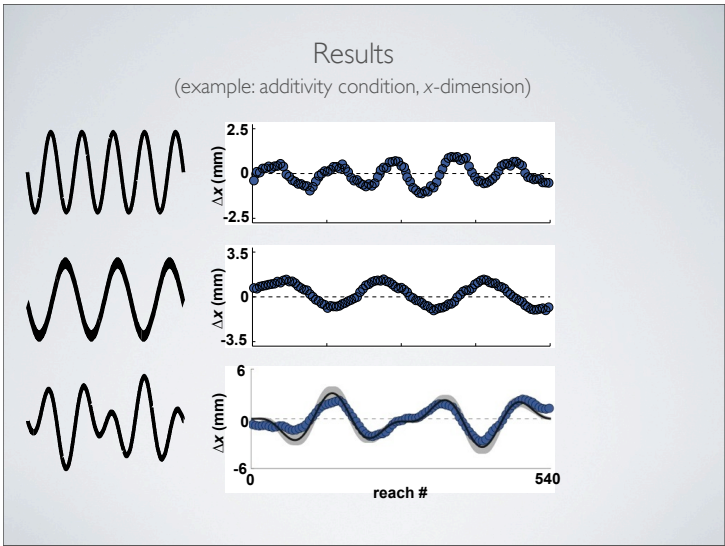
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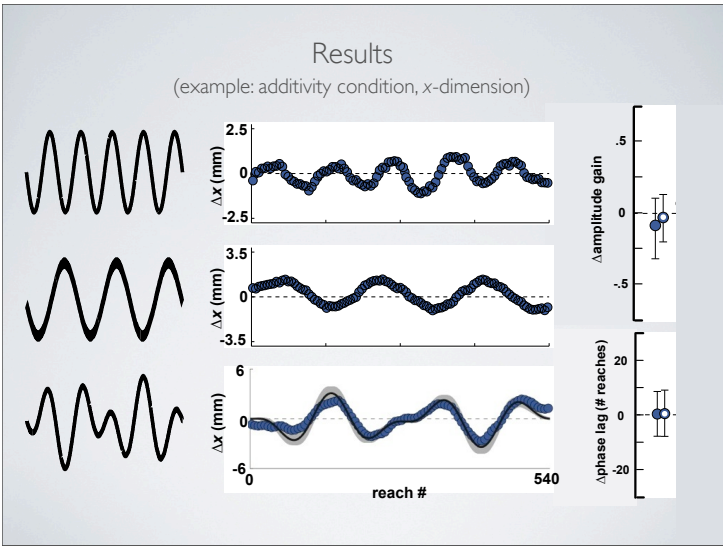
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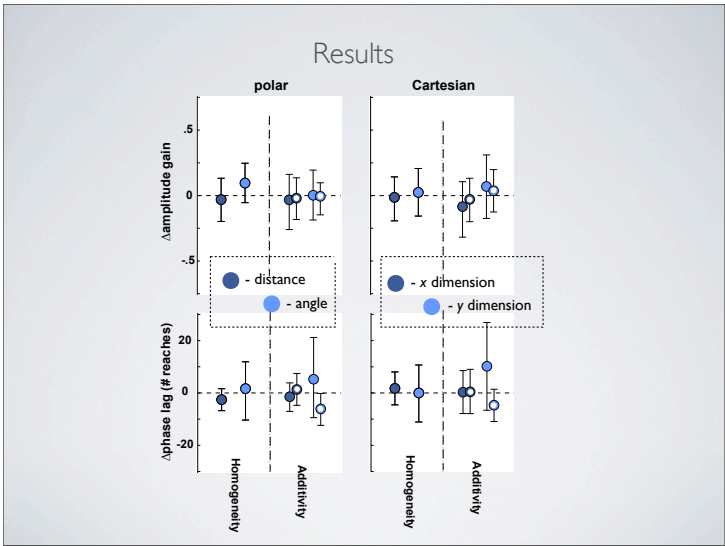
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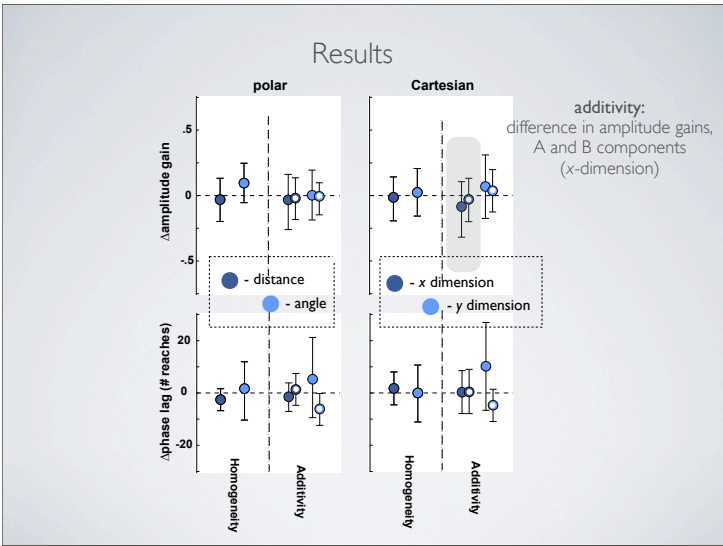
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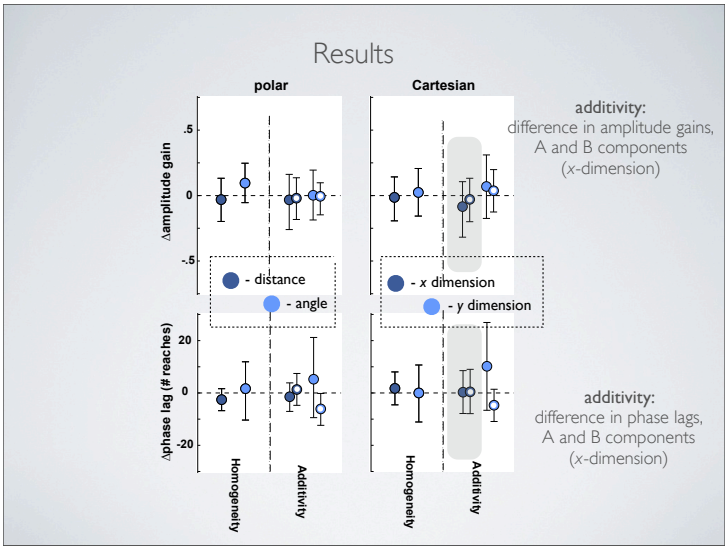
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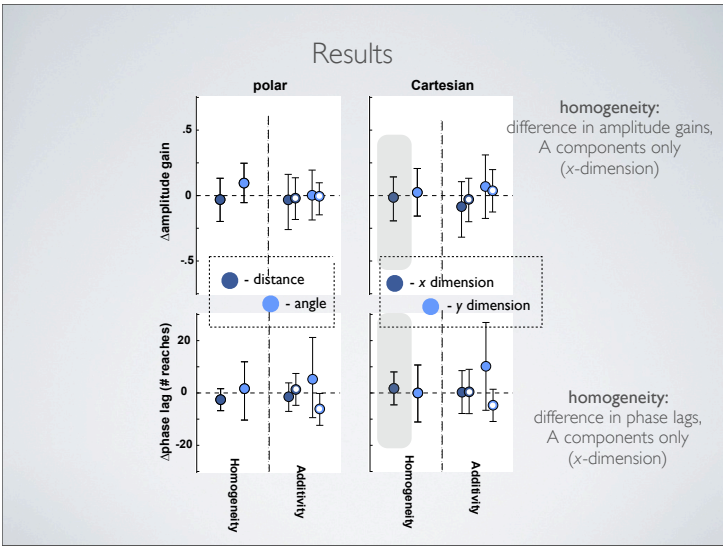
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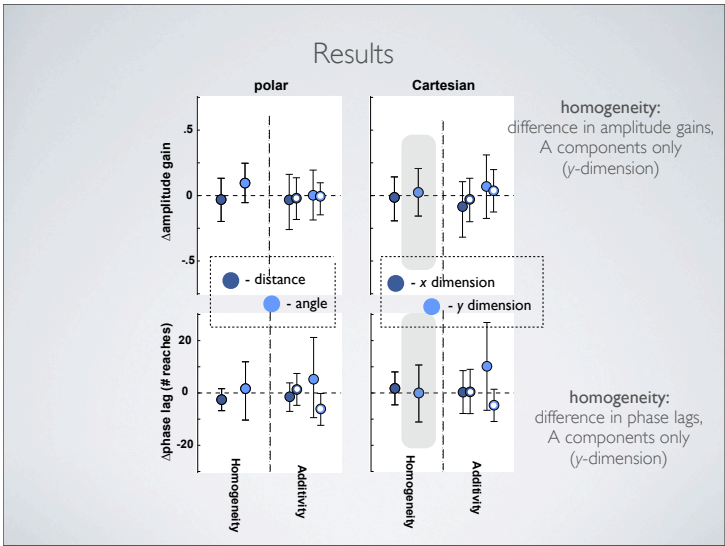
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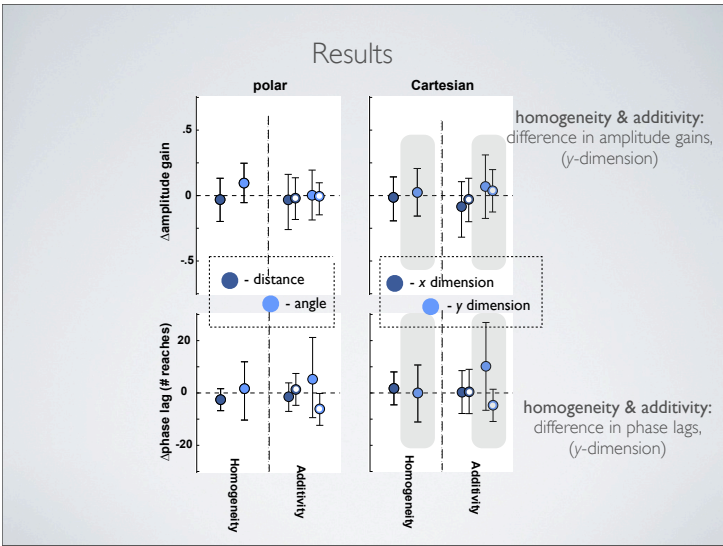
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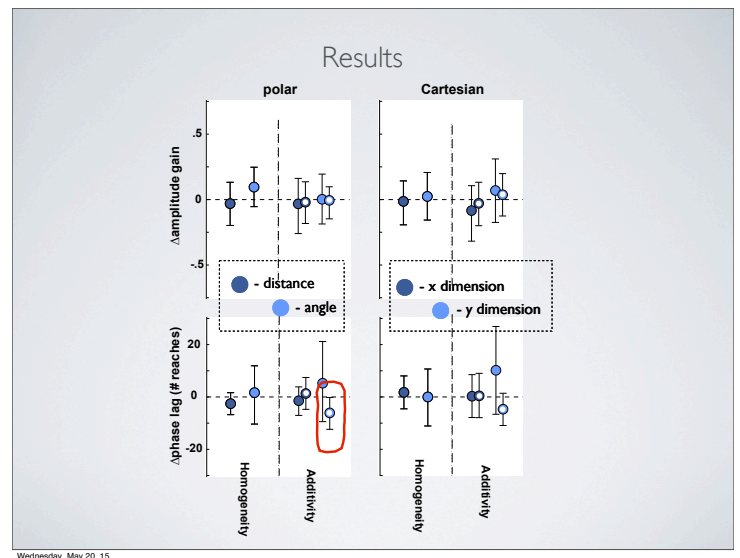
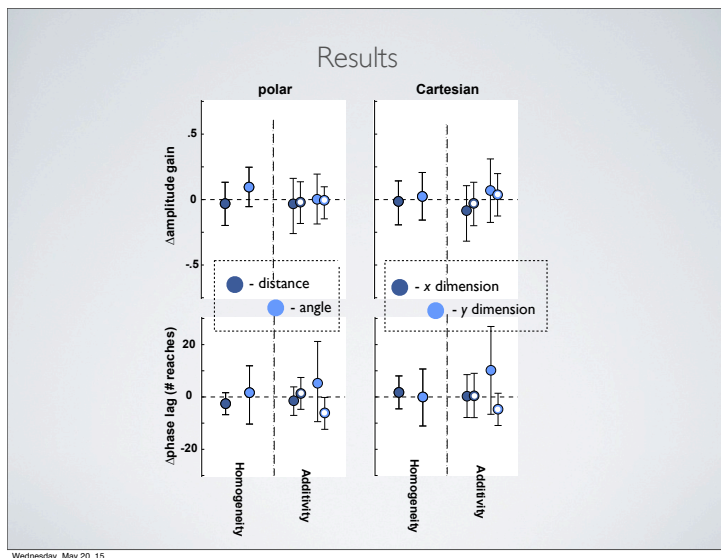
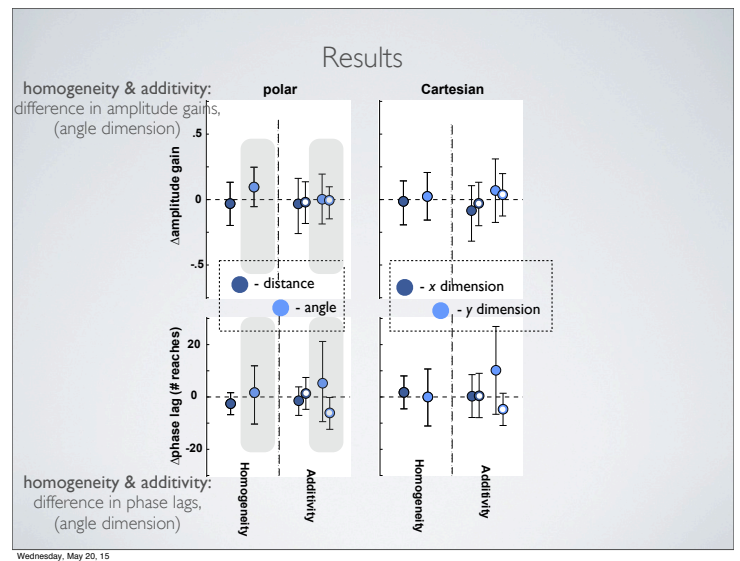
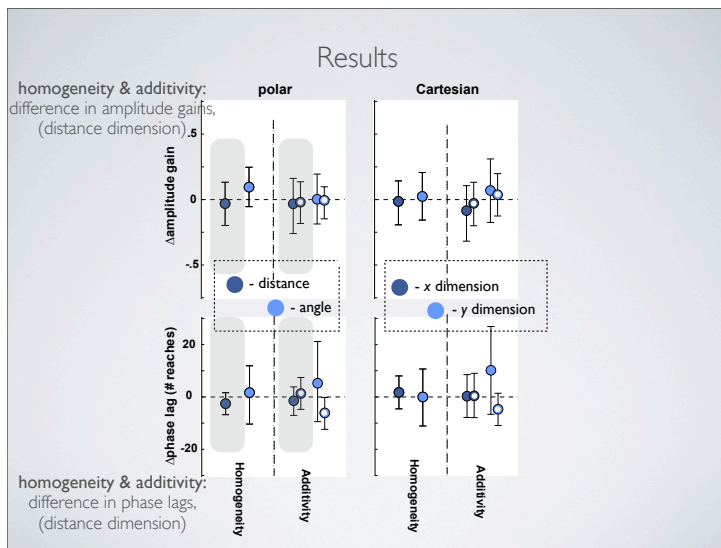


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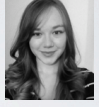



### Conclusion

- sensory-motor adaptation appears to be linear
- result holds for small perturbations at the frequencies tested
- also saw no evidence of nonlinear distortion products

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### Thank You!

					
mike landy	jay lee	zack westrick	gizem kucukoglu	elon gaffin-cahn	clapping bunny

Supported by: NIH EY08266

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