Spatial Working Memory: The Effects of Attention and Distractors for Children born Preterm and Fullterm

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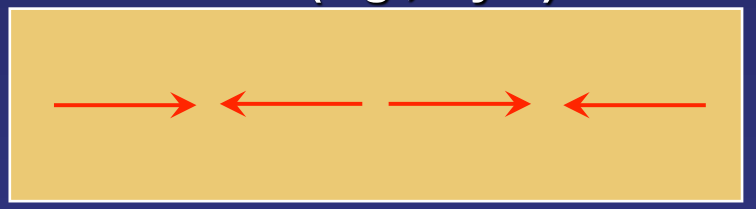
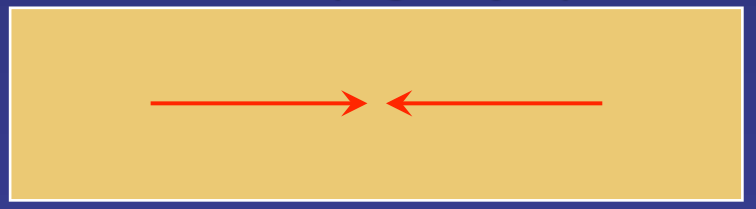
Outline

- Development of spatial working memory (SWM) in Early Childhood
- Dynamic Field Theory
- Spatial attention and spatial memory
  - Adults
  - Children
- Predictions of model
- Current study
  - Experiments 1 and 2

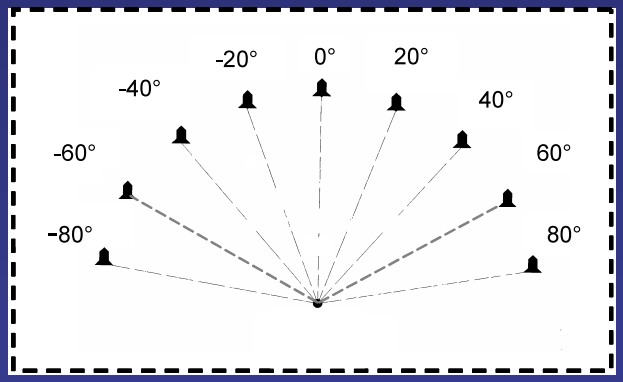
Development of SWM in Early Childhood

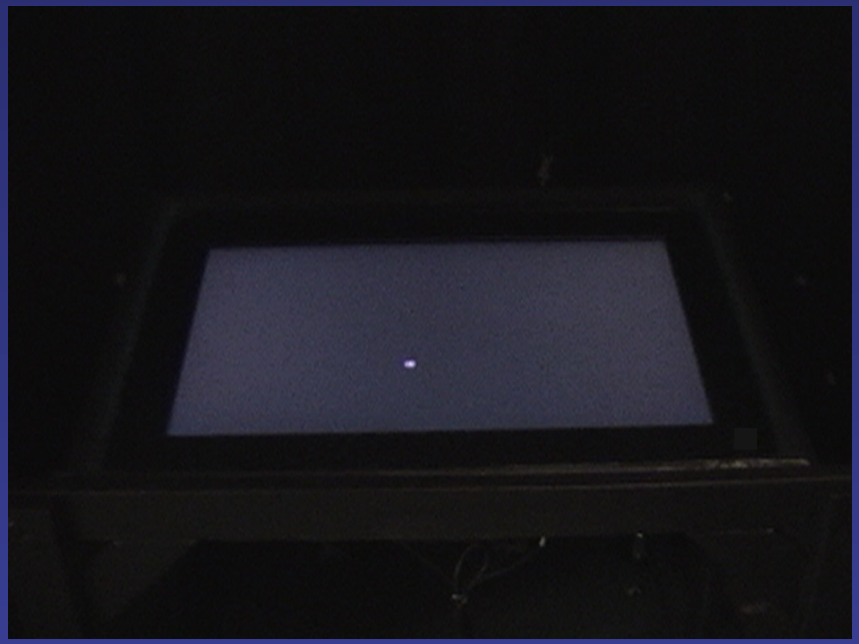
- A developmental shift in “geometric” biases (Huttenlocher et al., 1994)





Spatial Memory Video Game

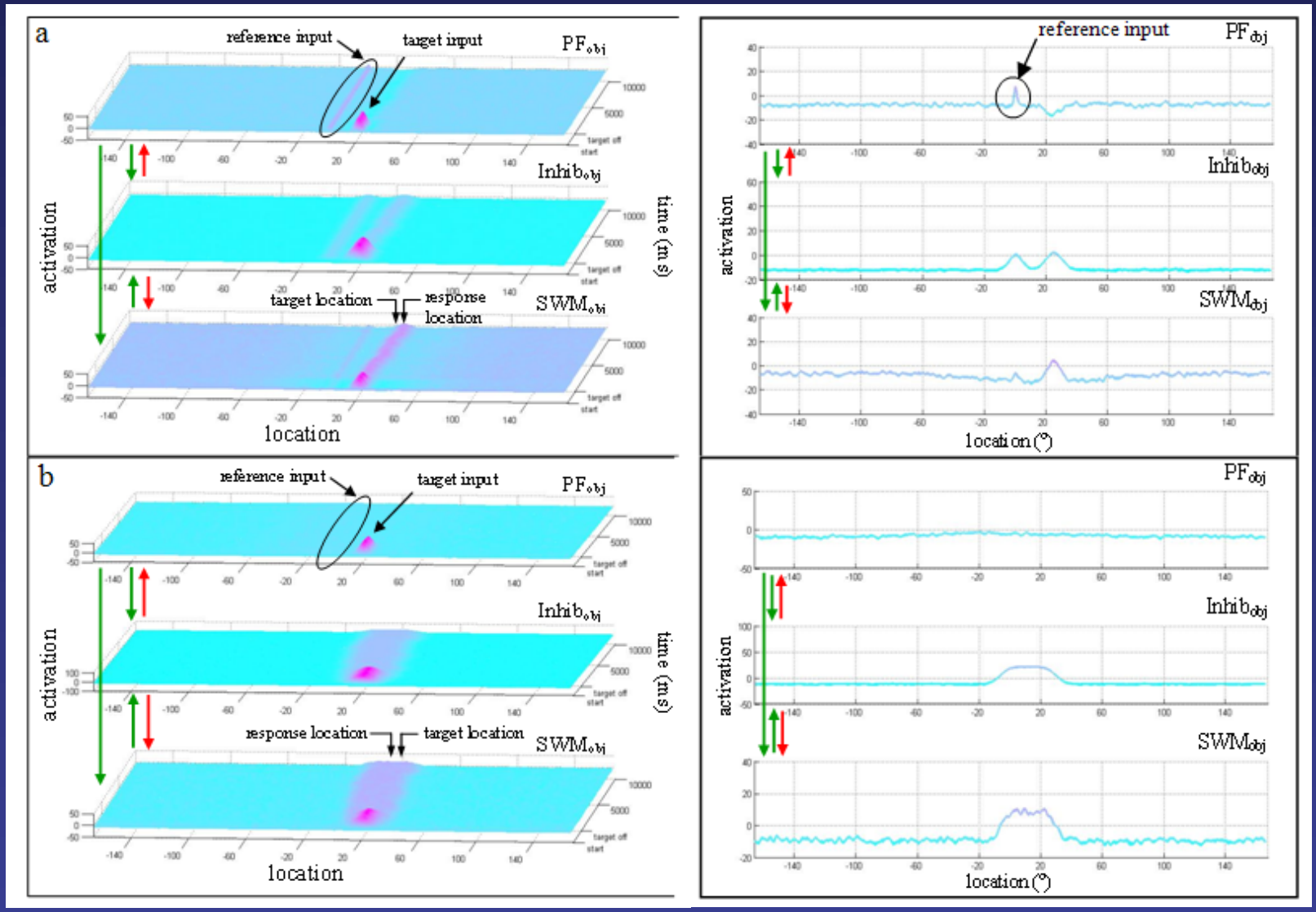




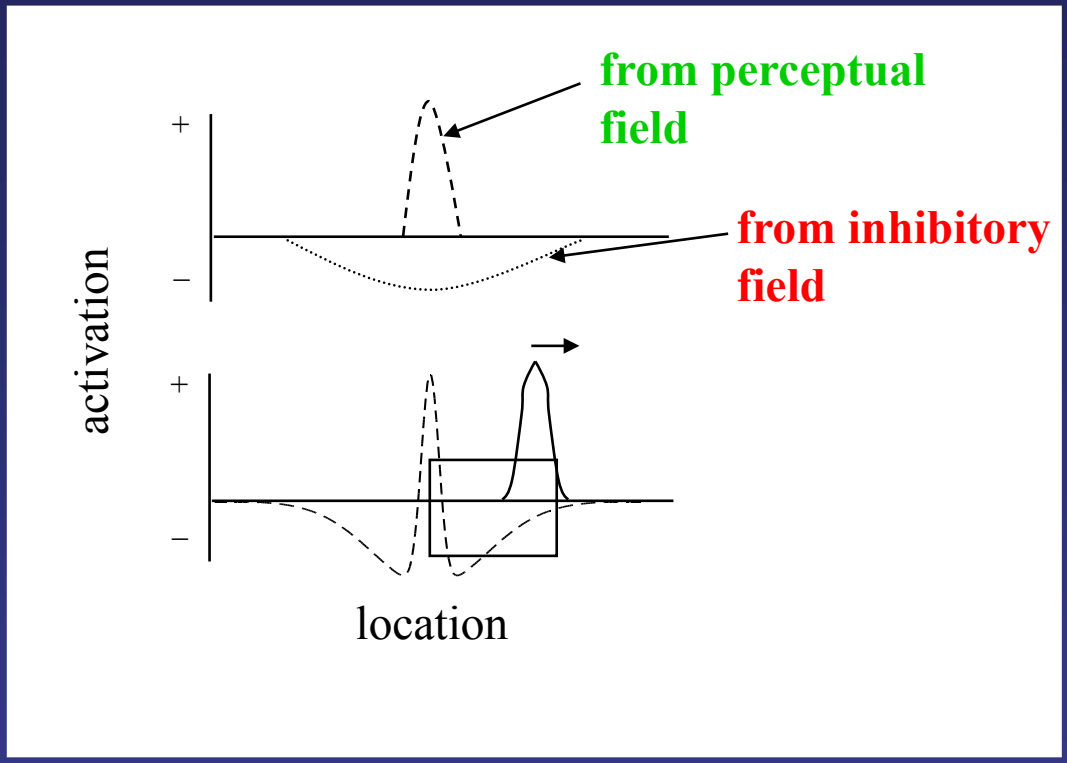
Dynamic Field Theory (DFT)

- Dynamic systems theory of Spatial Working Memory (SWM)
- Neural network model (e.g., Schutte, Spencer & Schöner, 2003; Schutte & Spencer, 2009; Schutte & Spencer, in press)

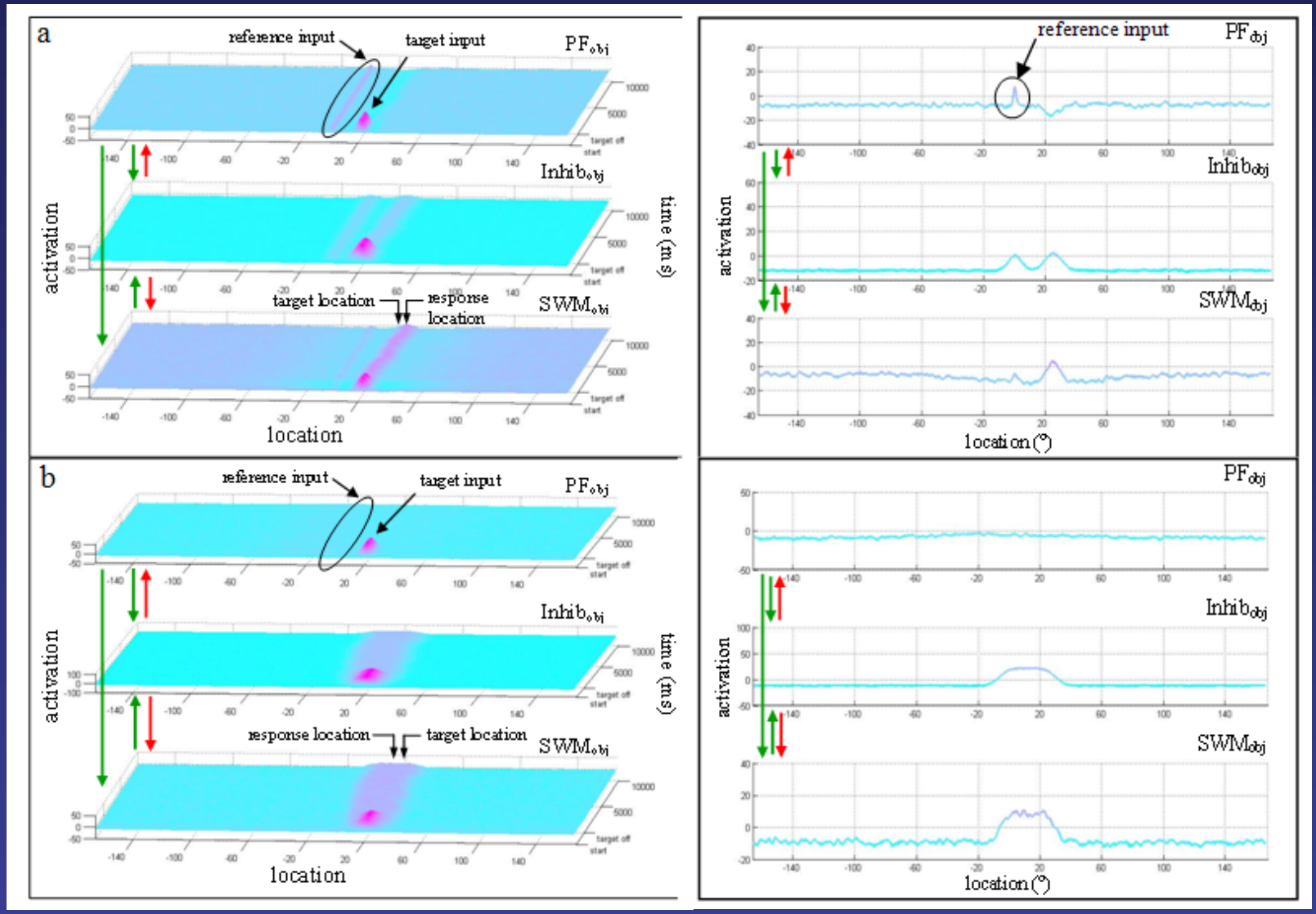
Dynamic Field Theory



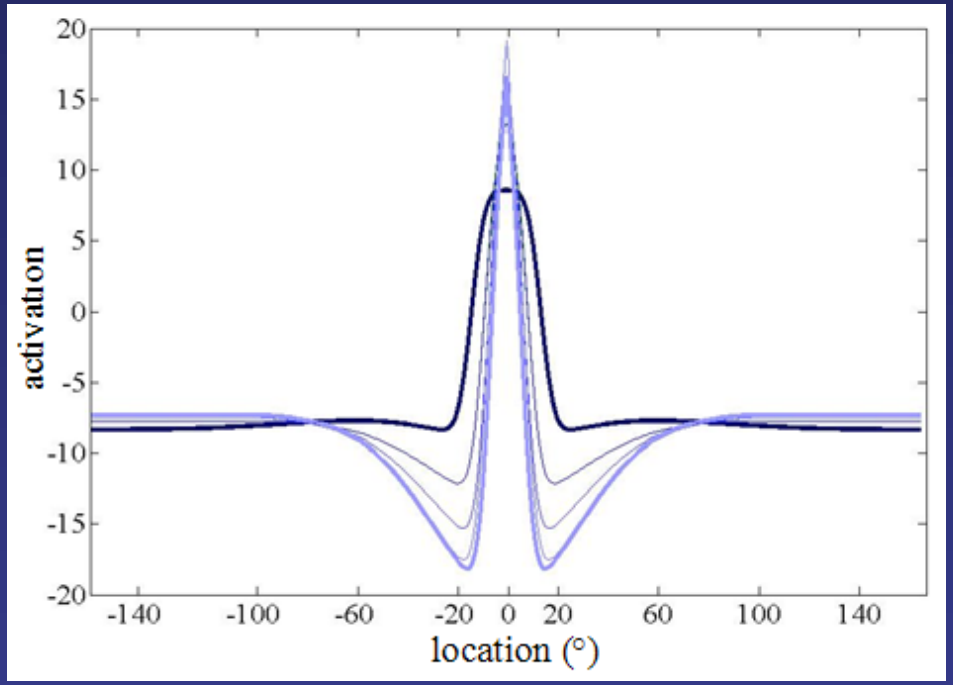
Reference input (midline)

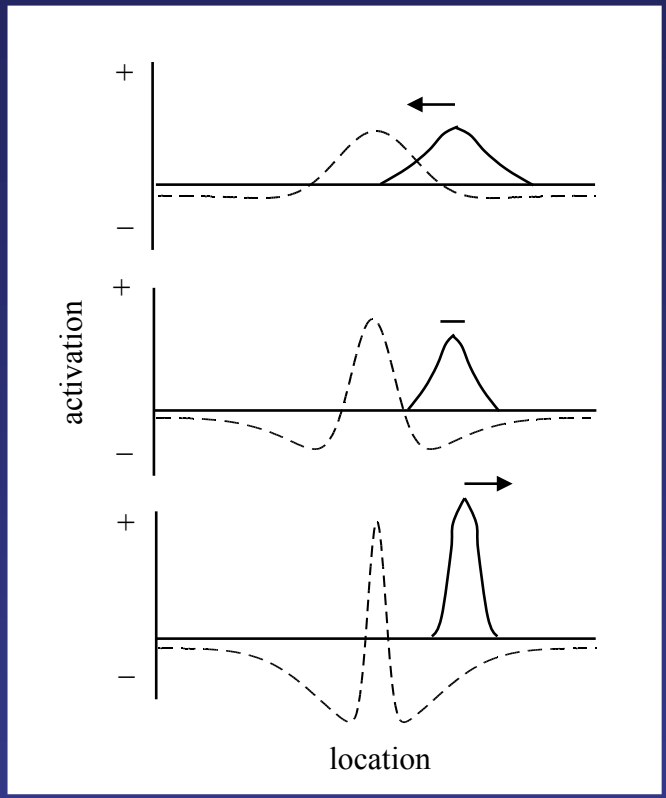


Dynamic Field Theory

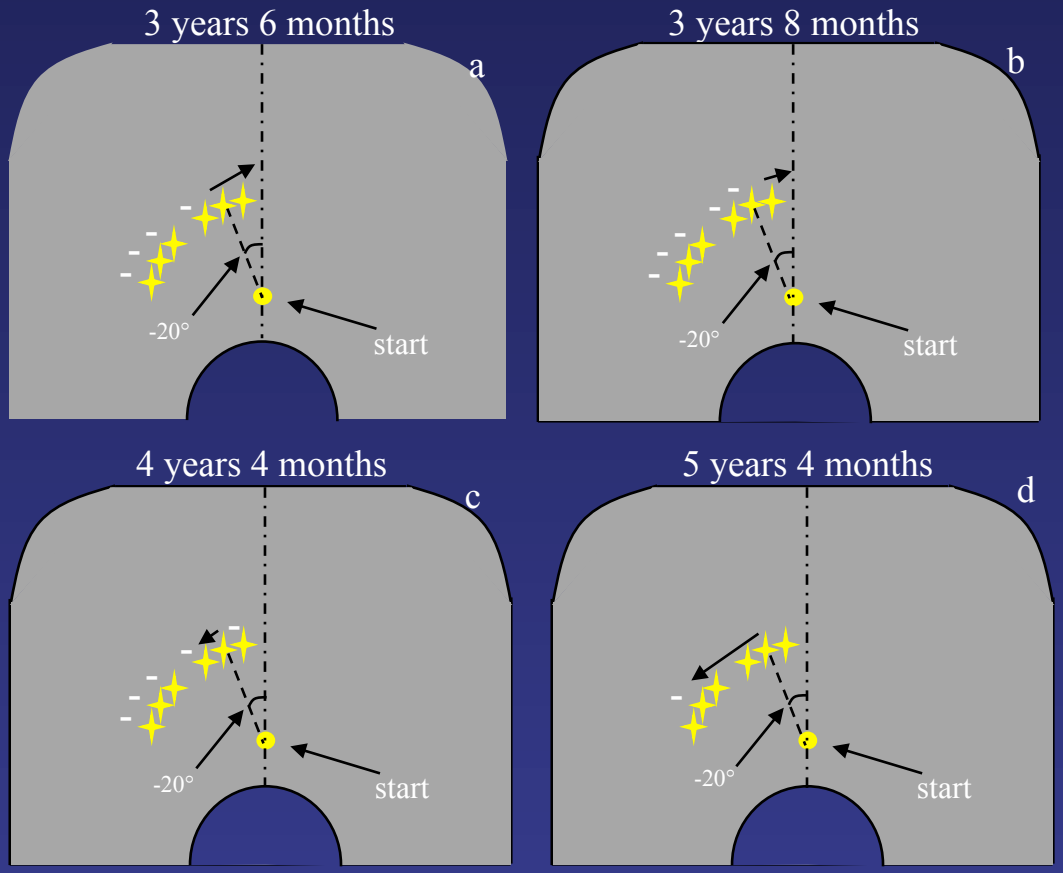


Spatial Precision Hypothesis

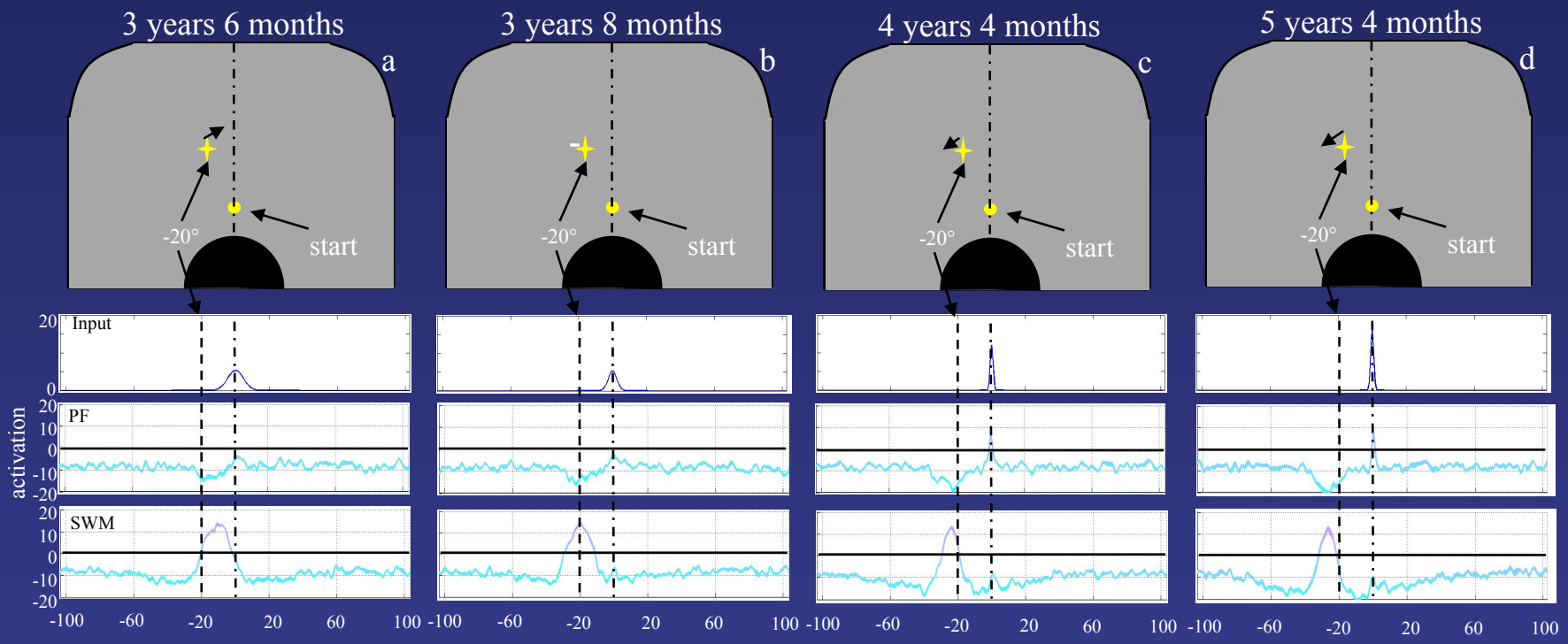



+
–
+
–
activation
+
–
location

Geometric biases over development



Schutte & Spencer, in press



Schutte & Spencer, in press

Spatial Attention and Spatial Working Memory (SWM)

- Spatial attention influences maintenance in SWM in adults (e.g., Awh and Jonides)
  - Proposed selective spatial attention is a "rehearsal mechanism" for SWM
  - When spatial attention is manipulated during the delay adults show larger errors
    - Adults are biased toward attention location (Johnson et al., 2008)

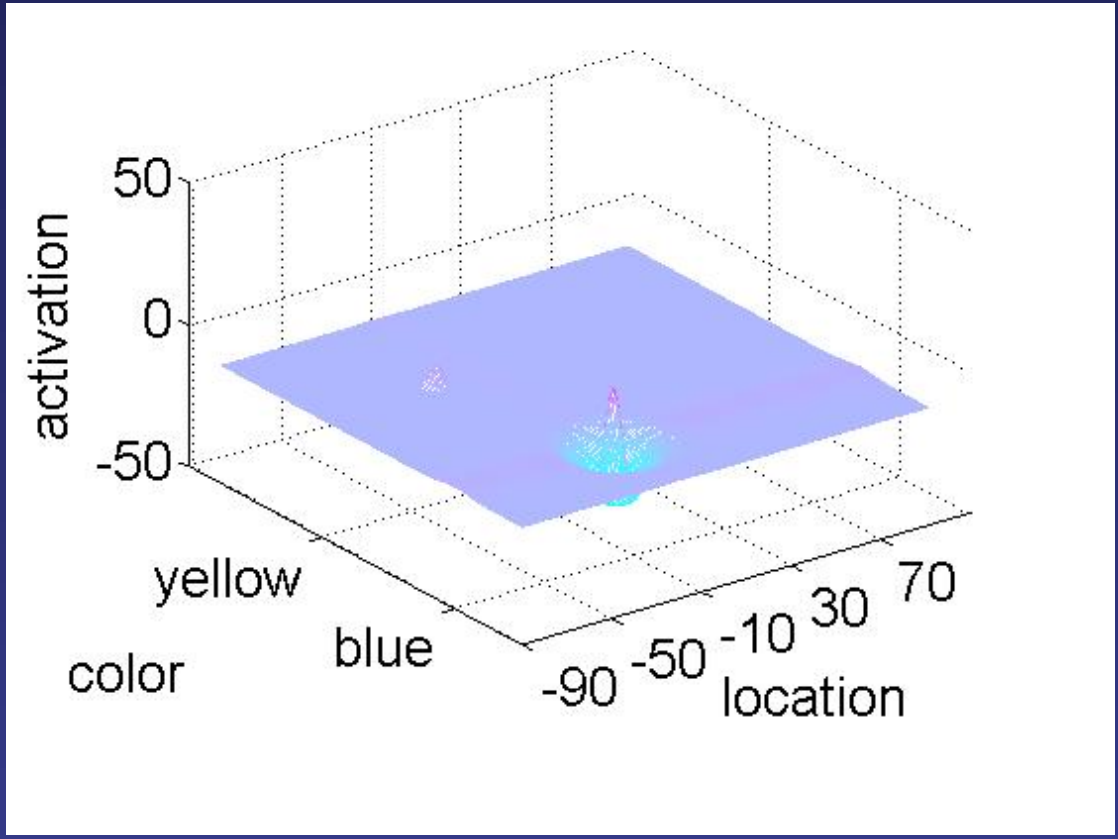
Spatial Attention and Spatial Working Memory (SWM)

- Preschoolers: no correlation between attention performance and SWM performance (Vicari et al., 2004)

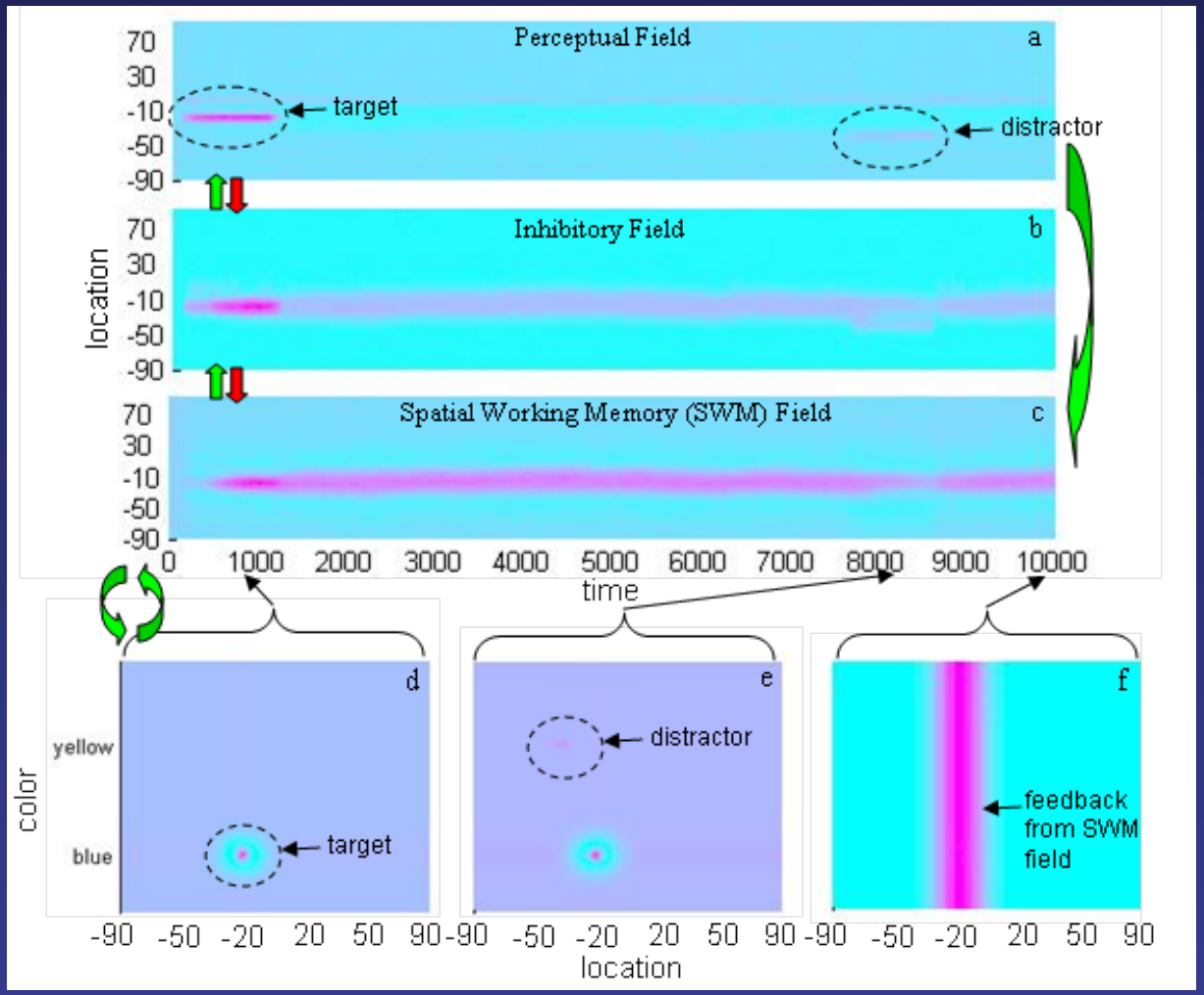
Purpose of the Study

- To examine how spatial attention influences SWM in children from 3 to 6 years of age.
- Examine in model and children
- Model: no mechanism for differentiating target and distractors
  - Added color-space field (Johnson & Spencer, 2010)

DFT: Color-Space Field



Dynamic Field Theory



-20° target

	No distractor	0º distractor (on midline)
3-year-old model	-2.41 (toward midline)	
6-year-old model	.14 (away from midline)	

-20° target

	No distractor	0º distractor (on midline)
3-year-old model	-2.41 (toward midline)	-11.6
6-year-old model	.14 (away from midline)	1.16

Predictions of Model

- Young children will be biased toward distractor when it is near the target
  - due to excitatory input
- Older children will be biased away from the distractor when it is near the target
  - due to inhibitory input

Experiment 1 Methods

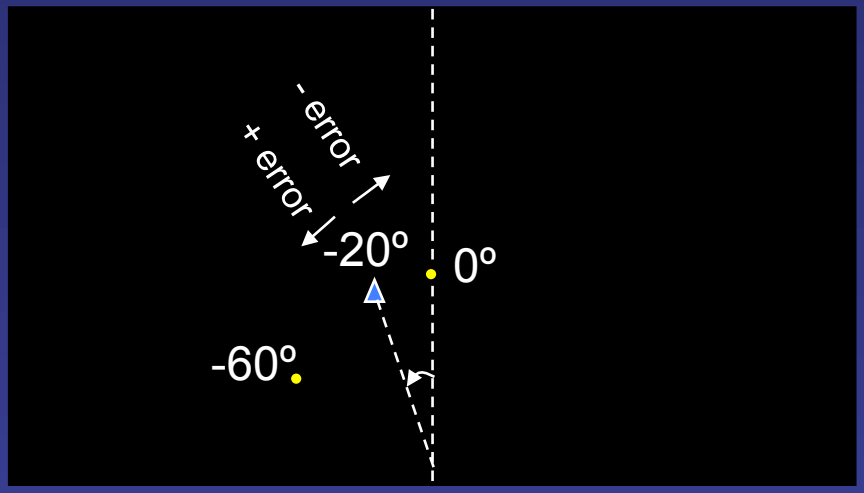
- Participants
  - *15* 3-year-olds
  - *13* 4-year-olds
  - *15* 5-year-olds
  - *15* 6-year-olds

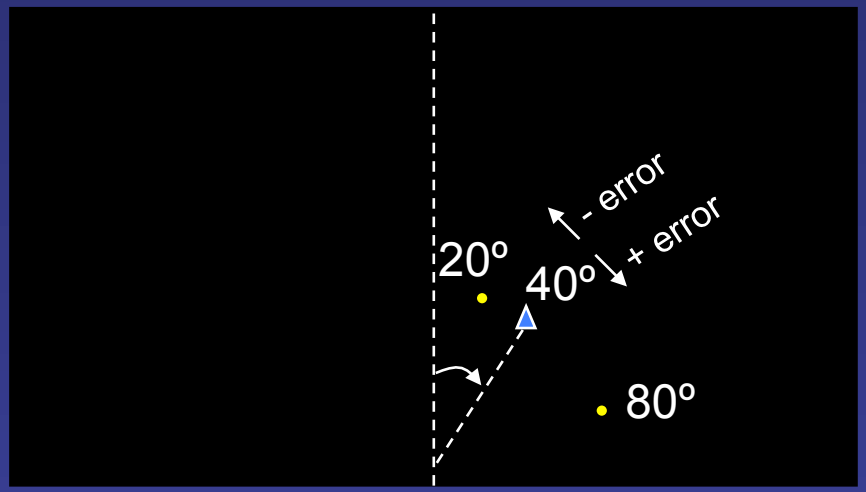
Method

- SWM tasks
  - Spaceship search
  - Treasure find
  - Bubble burst
- Delay: no delay, 1 s, 4 s, or a 9 s

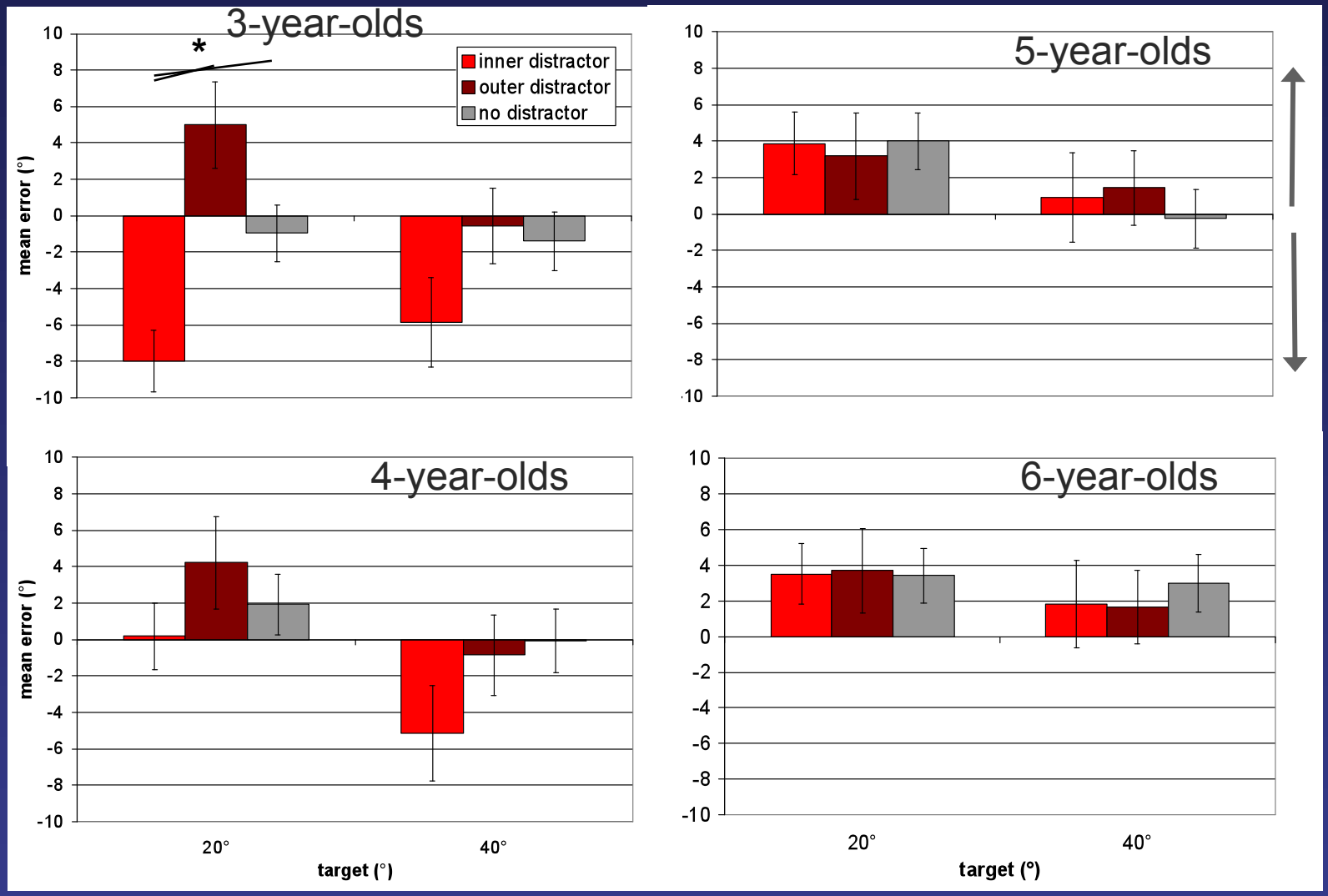
Method

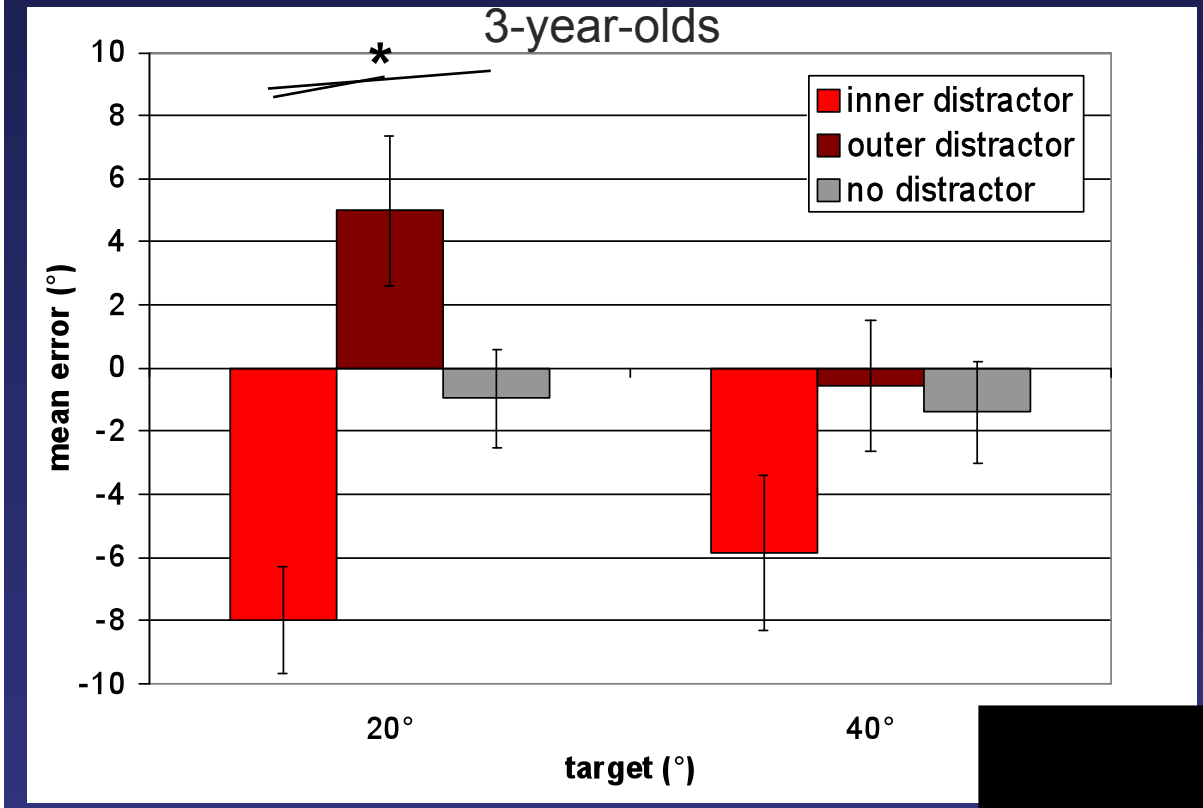
- Targets: -20 degrees from midline or 40 degrees from midline
- Distractor appeared on half of the 4 and 9 s delay trials
  - 20º toward midline (inner)
  - 40º away from midline (outer)

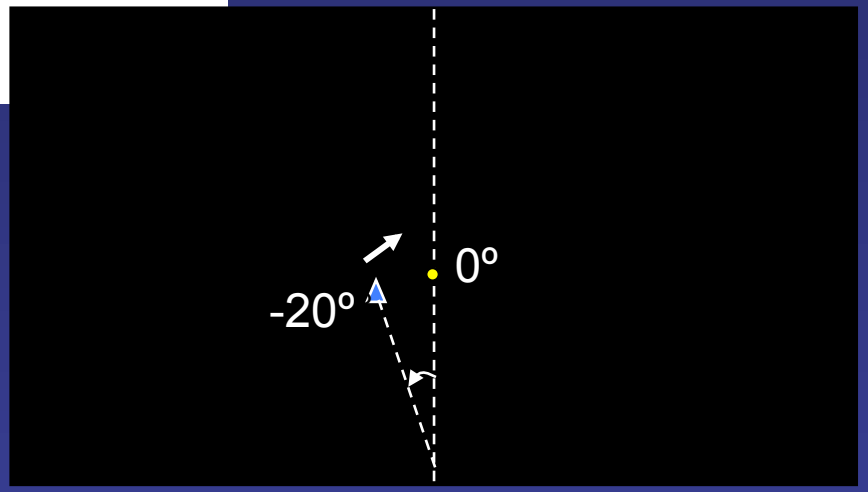


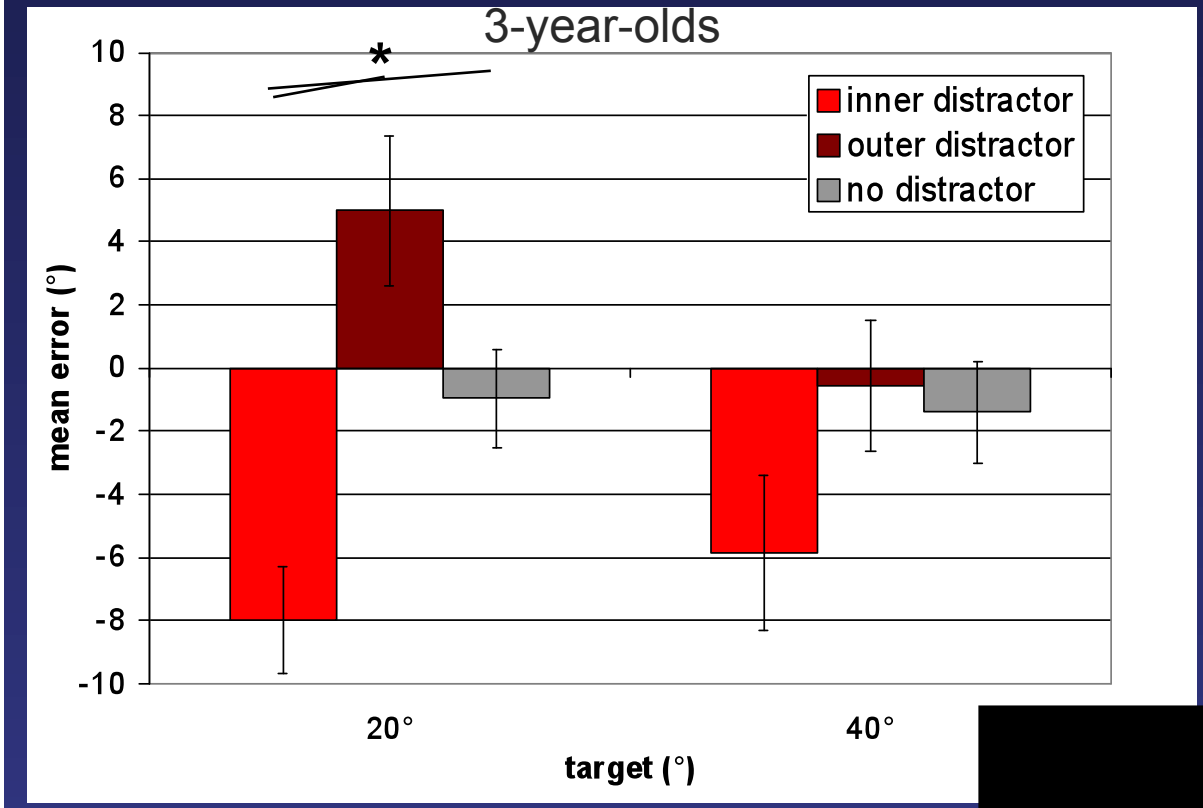


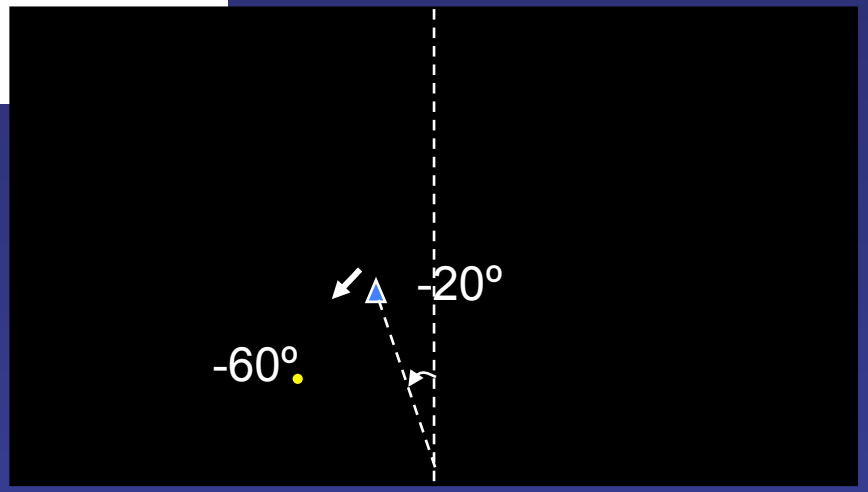
Results


3-year-olds
*
inner distractor
outer distractor
no distractor
mean error (°)
10
8
6
4
2
0
-2
-4
-6
-8
-10
5-year-olds
4-year-olds
6-year-olds
20°
40°
target (°)
toward midline
away from midline


3-year-olds
*
inner distractor
outer distractor
no distractor
mean error (°)
10
8
6
4
2
0
-2
-4
-6
-8
-10
20°
40°
target (°)


0°
-20°


3-year-olds
*
inner distractor
outer distractor
no distractor
mean error (°)
10
8
6
4
2
0
-2
-4
-6
-8
-10
20°
40°
target (°)

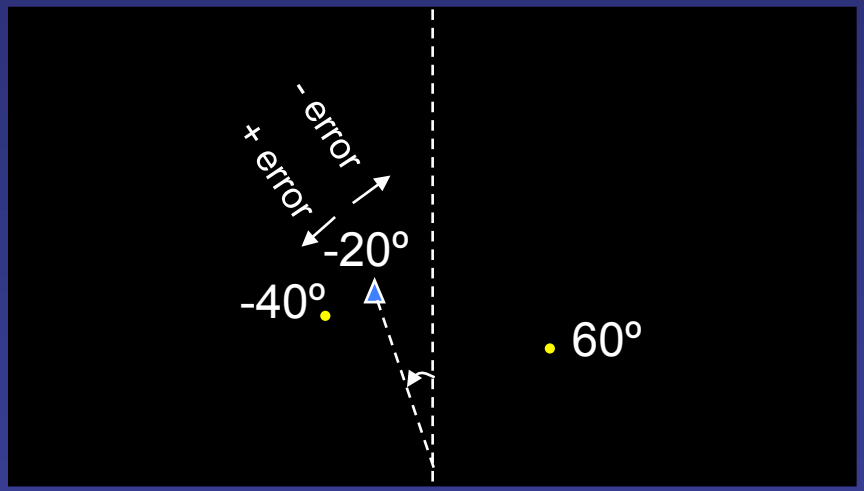

-20°
-60°

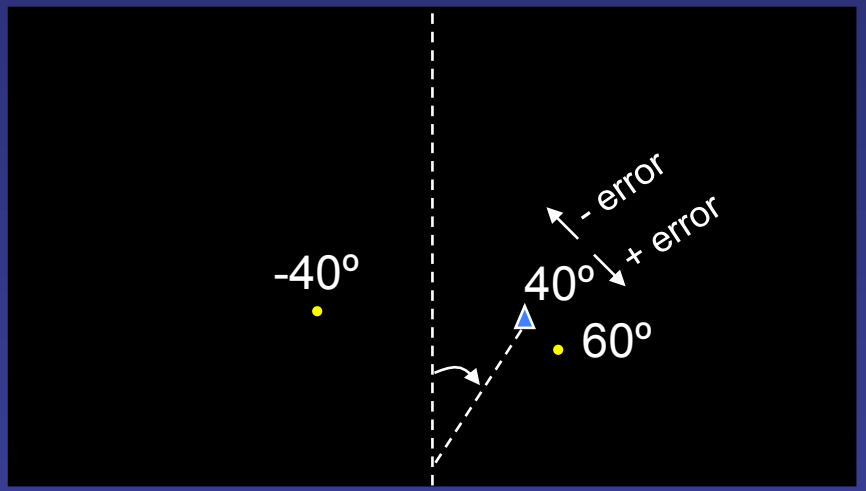
Discussion

- 3-year-olds were biased toward distractor
  - Supported prediction
- Other ages not influenced by distractor
  - 4 years: transitional age
  - 5 and 6 years biased away from midline, also biased away from closest distractor
- Experiment 2
  - Changed distractor locations

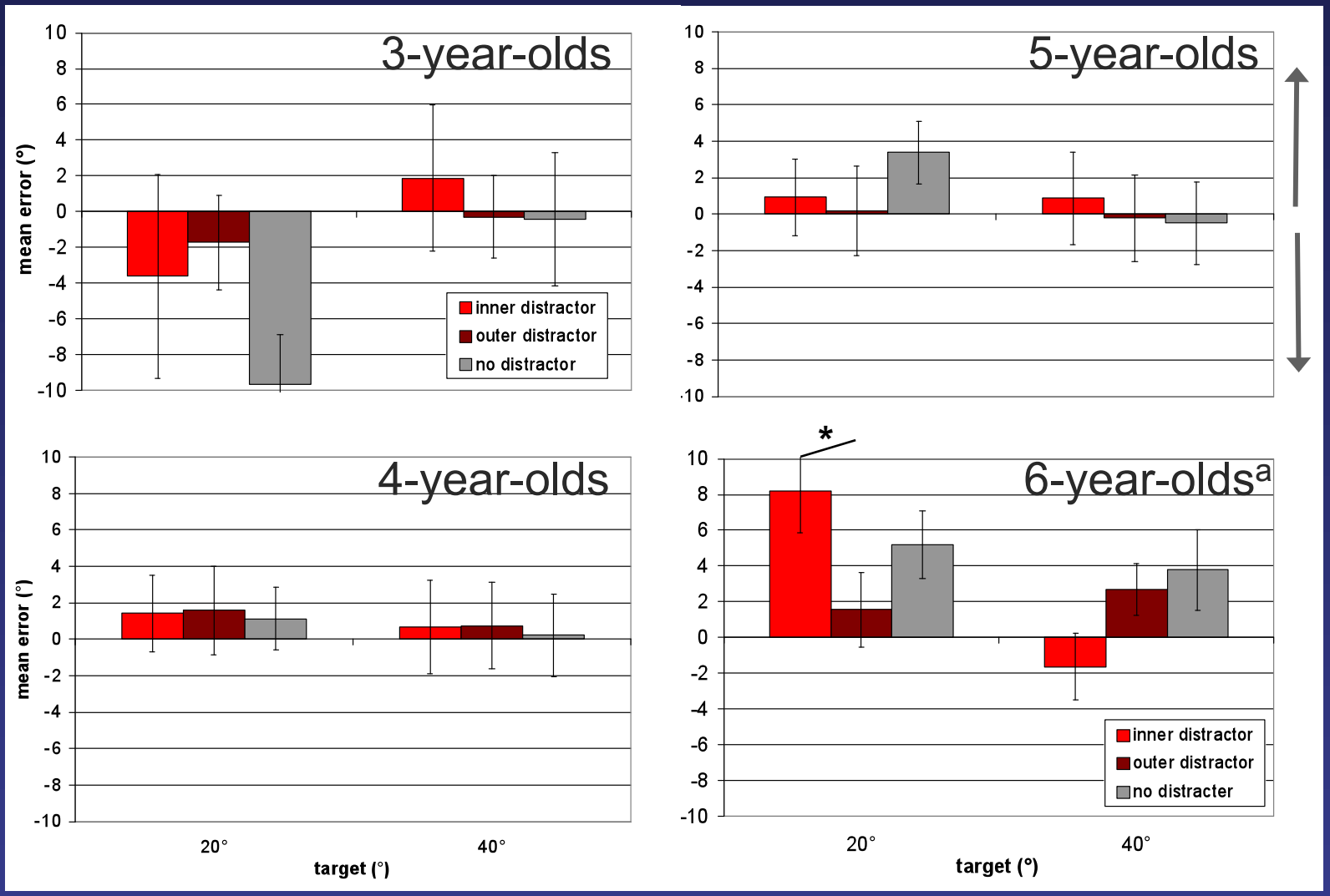
Experiment 2
Method

- Participants
  - *10* 3-year-olds
  - *12* 4-year-olds
  - *12* 5-year-olds
  - *11* 6-year-olds
- Target and distractors:

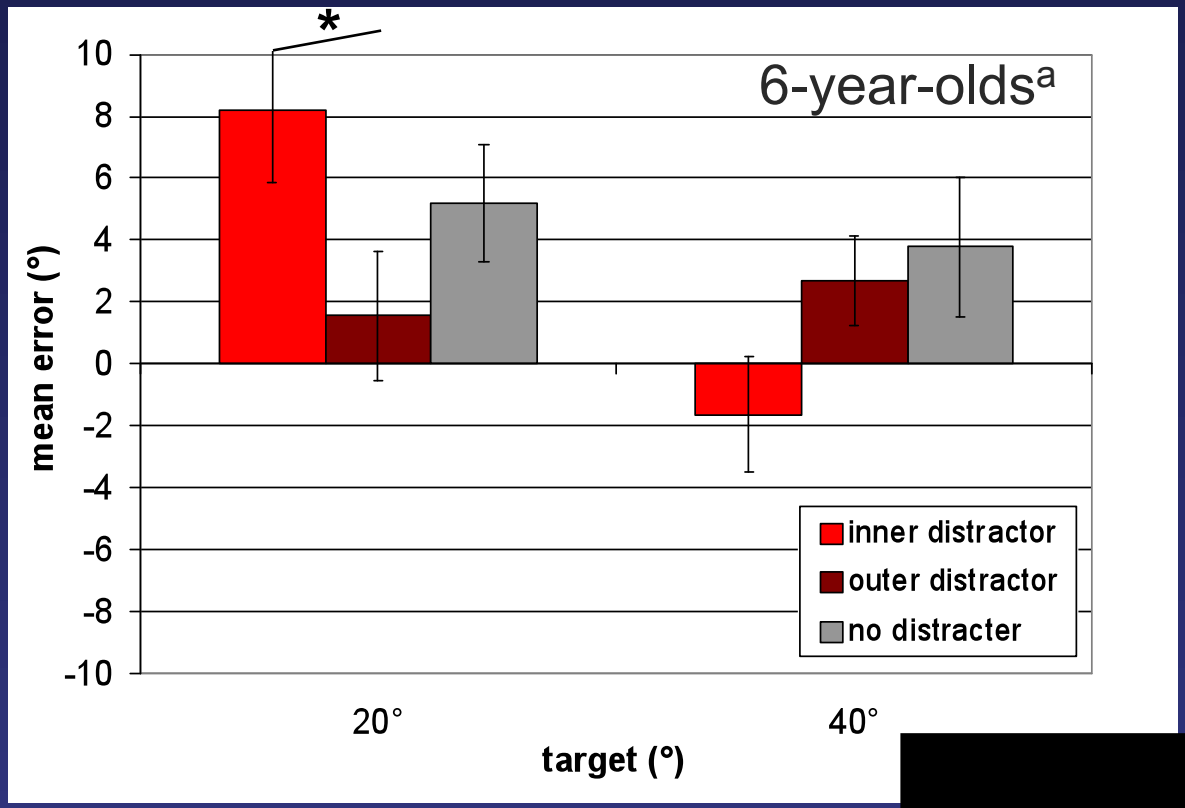




Results



[a] 9 s delay data



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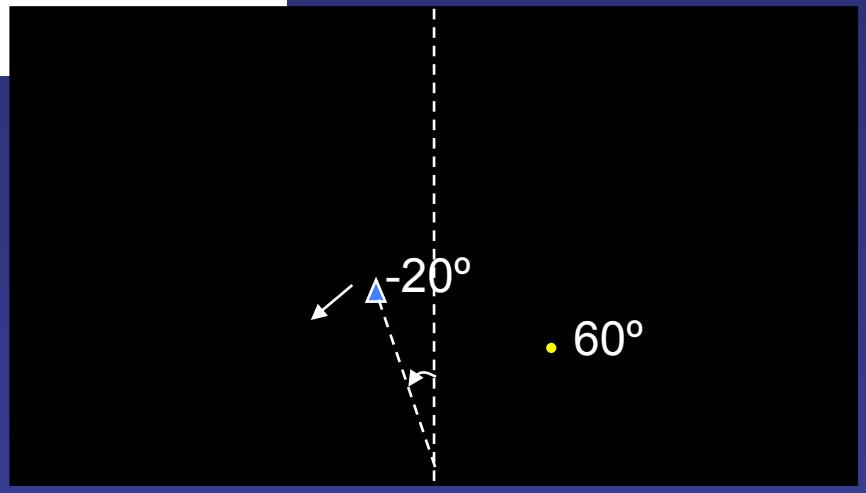
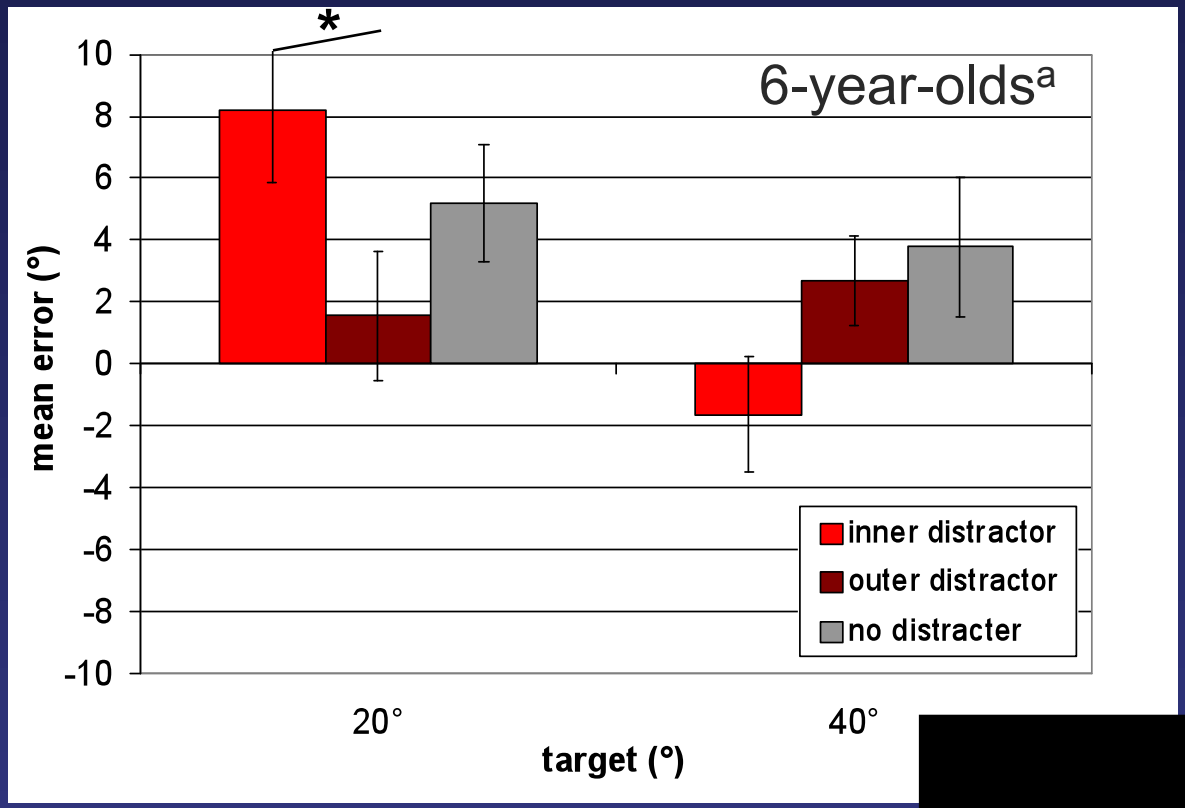
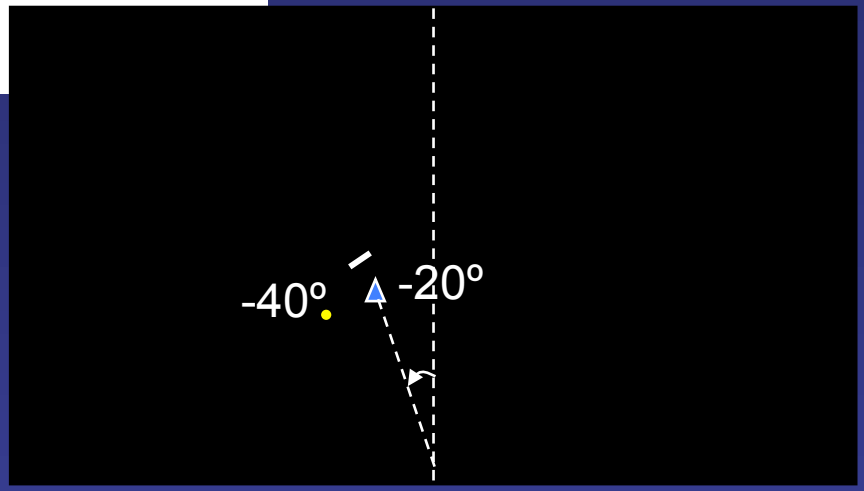




[a] 9 s delay data



Discussion

- Experiment 1 results support the predicted bias toward distractors in 3-year-olds
- Experiment 2 results support the predicted bias away from distractors in 6-year-olds
- Children at or near transition not significantly influenced by distractors

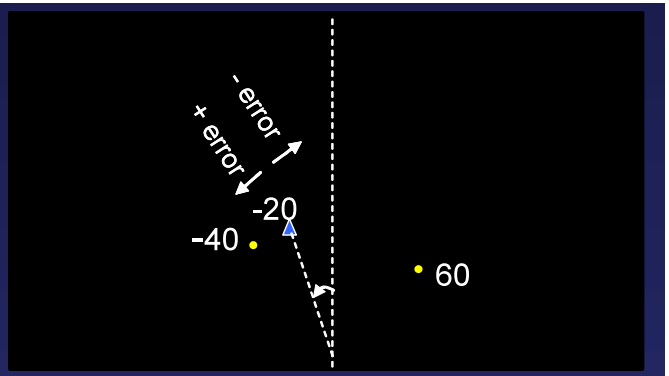
Discussion

- Spatial attention influenced maintenance in spatial working memory in early childhood
  - Shifted bias
  - How distractors influenced bias changed over development
- Supported predictions of the DFT
- Future directions:
  - Examine SWM performance in children with attention deficits
    - ADHD
    - Preterm children

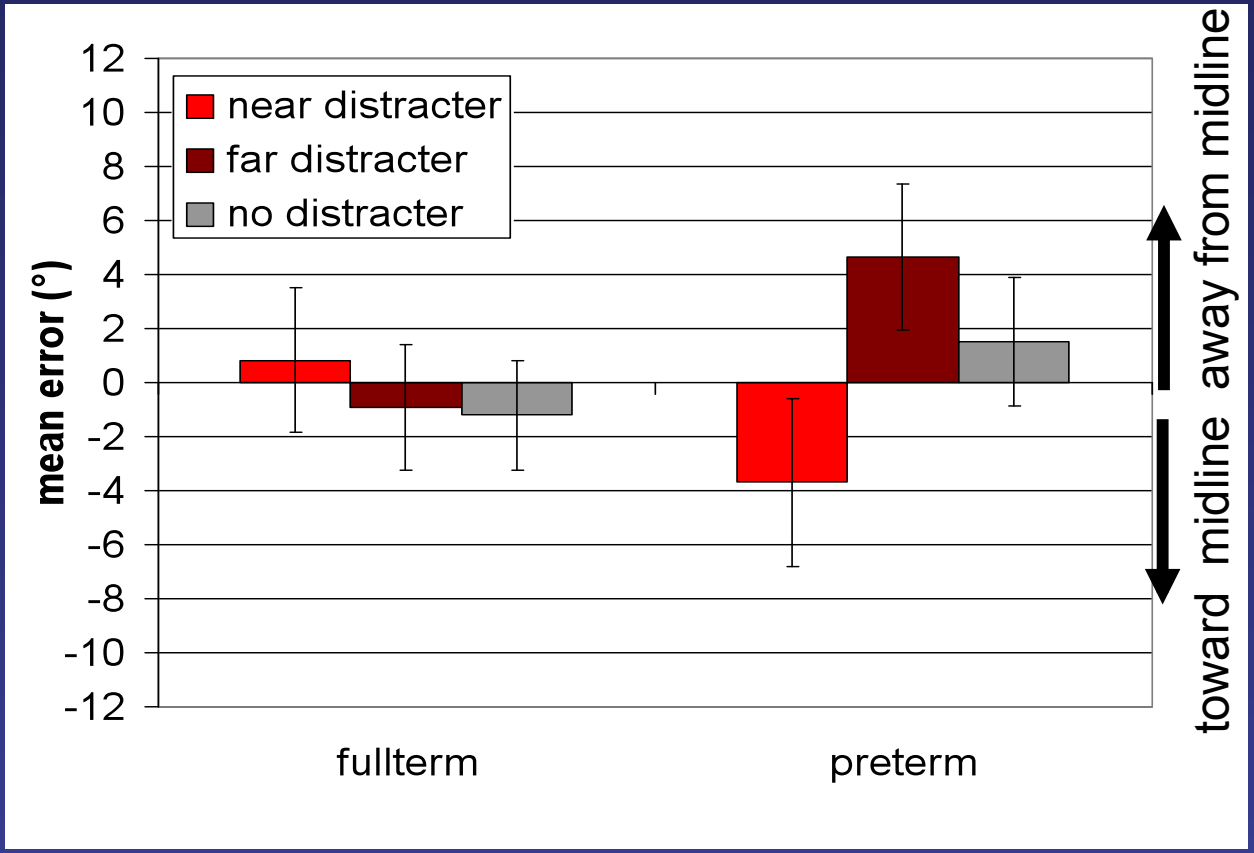
Thanks:

- Parents and children
- Dr. Kimberly Andrews Espy
- Dr. Sandra Wiebe
- Members of the Spatial Memory Lab:
  - Brian Keiser
  - Heidi Fleharty
  - Margaret Ortmann
  - Chelsie Guerrraro
  - Marisa Sevick
  - And all of the undergraduates in the lab
- Research supported by R03 HD053359 and UNL Laymans grant

Results



4-year-olds



-20° target

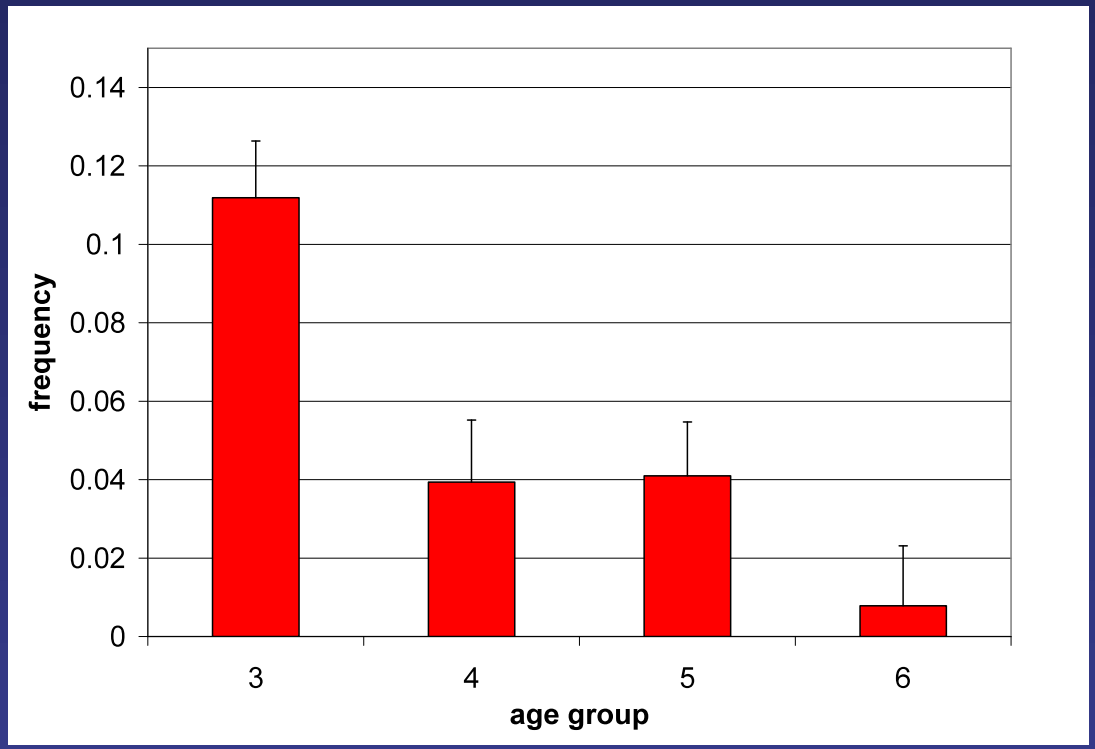
	No distractor	-40° distractor
3-year-old model	-5.56	8.60
6-year-old model	4.89	.73

-20° target – Empirical data

	No distractor	-40° distractor
3-year-olds	-6.48	-0.96
6-year-olds	4.43	-2.70

Results

- A-not-B-type errors



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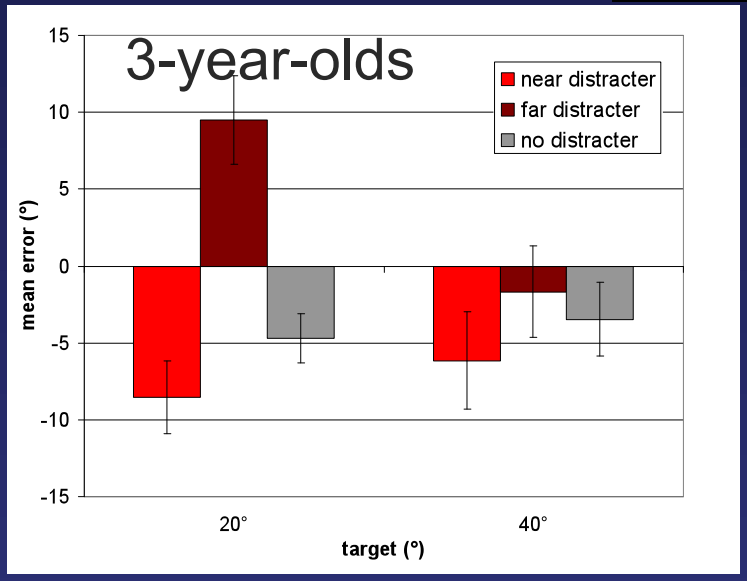
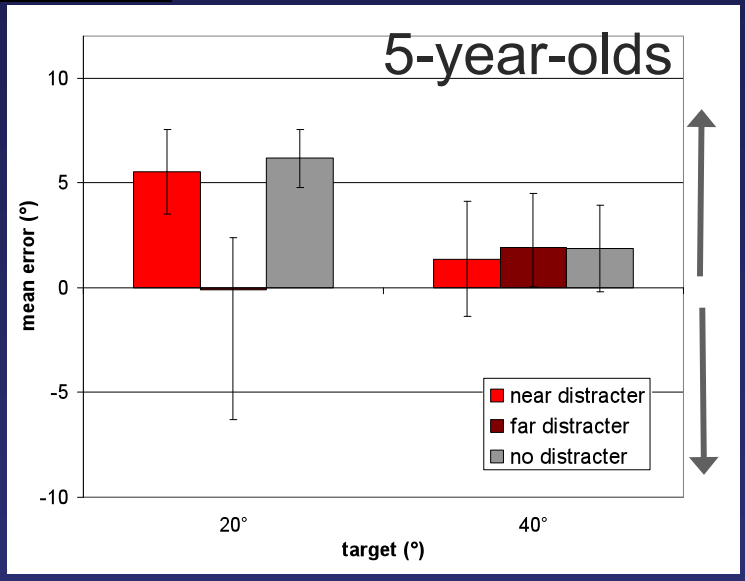
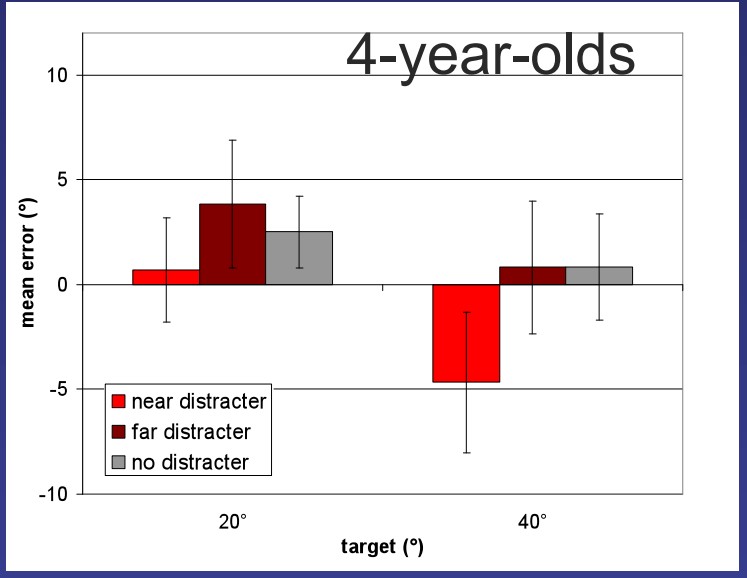
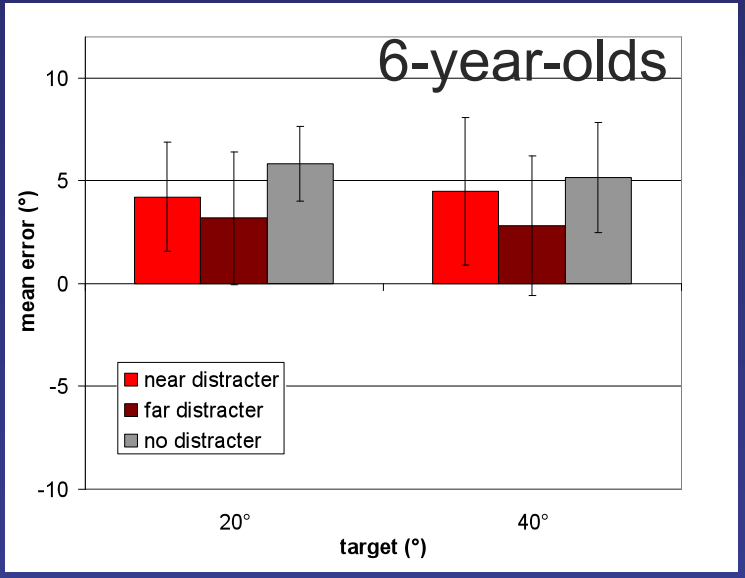


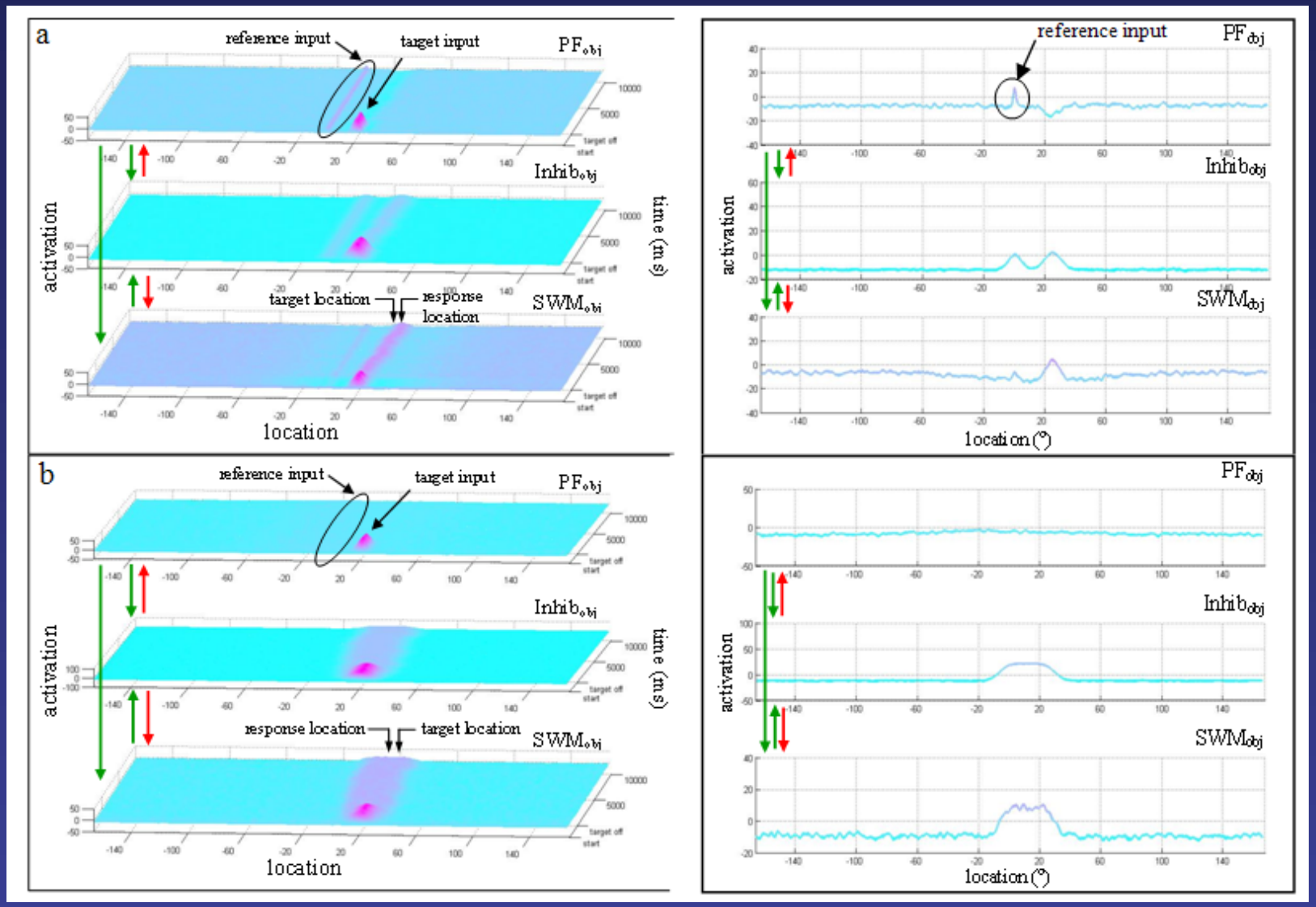


toward midline away from midline



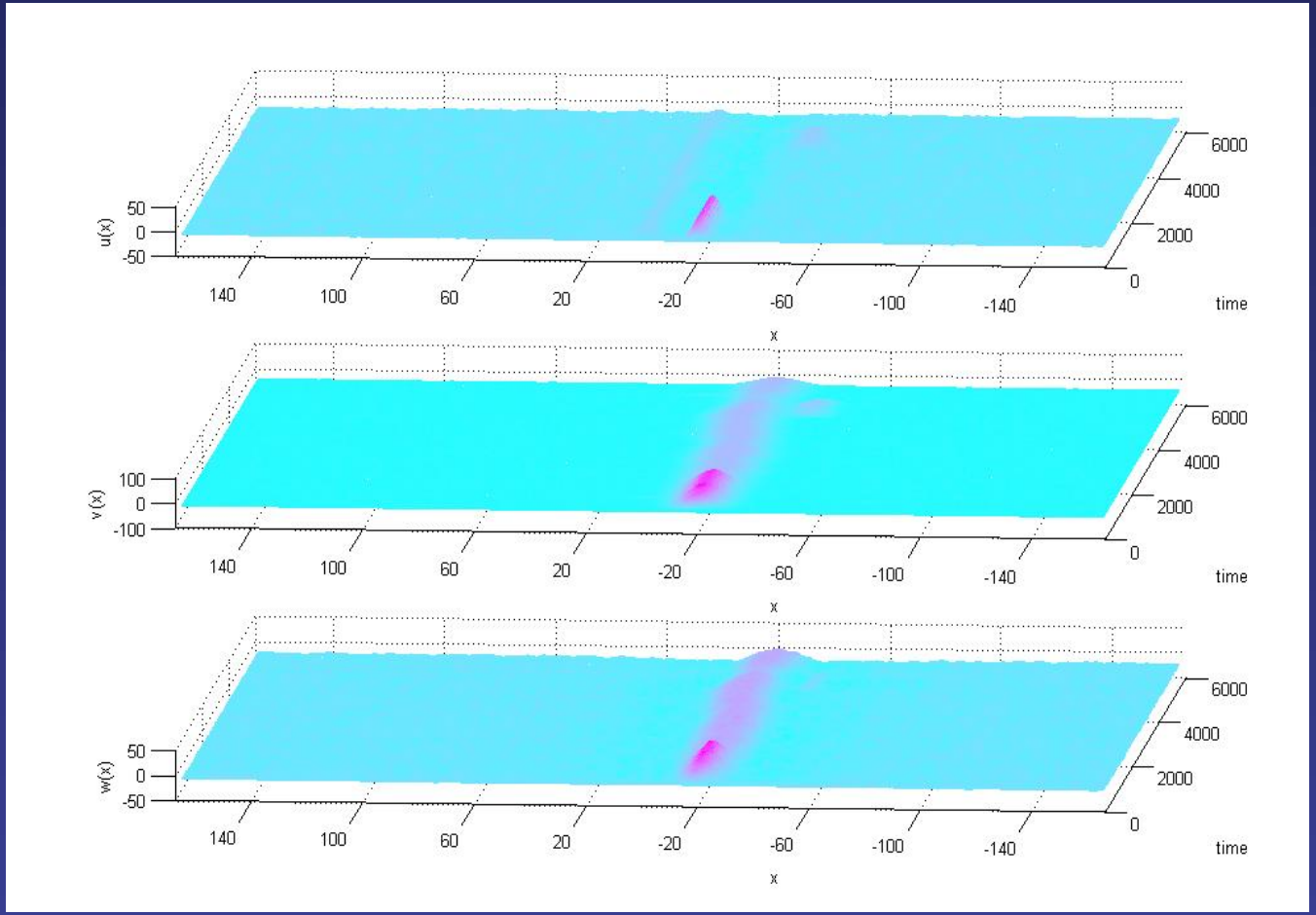


Dynamic Field Theory



Dynamic Field Theory

Young child: biased toward distracter



Dynamic Field Theory

Older child: biased away from attractor