A Longitudinal Study of the Development of Spatial Working Memory in 3-year-olds
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Background and Significance
- Early in development, there is a transition in spatial working memory (SWM)
- In a homogeneous space (like a sandbox), children 3 years of age or younger are biased toward the midline symmetry axis of the space
- Between 3½ and 18 years of age, there is a transition that leads to older children being biased away from the midline
- The Category Adjustment model (CA) (Huttenlocher, Newcombe, & Sandberg, 1994) proposes that the transition in memory biases is due to a change in how children and adults form spatial categories
- Two types of information are used to encode a location of an object
  - Categorical Information – includes the boundaries of the category and the category prototype which is the location at the center of the category
  - Fine-grained Information – provides information about distance and direction from the boundaries or the prototype
- People combine these two types of information at recall and are biased toward the prototype
- Young children treat the homogeneous space as one category and are biased towards the center of the category (the most prototypical location, according to Huttenlocher and colleagues)
- Adults and older children divide the space into two categories and are biased toward the center of each half

The Dynamic Field Theory (DFT) proposes that the transition in SWM is due to changes in the strength of neural interactions in SWM and due to gradual changes in the perception of the symmetry axis (Schutte, Spencer, & Schneider, 2003, see also Ortmann & Schutte, 2009)

Schutte and Spencer (in press) studied the transition in SWM using a spaceship task
- It was found that the transition is gradual and depends on target location
  - This study was done cross-sectionally
  - Question: Does the transition occur gradually with children or was the gradual nature of the transition due to the cross-sectional nature of the study?

Method
Participants: 18 3-year old children (M=42.5 months, SD=1 month) 9 male and 9 female
- Demographic information was collected at the first visit
- Visits were once a month for four months
- Apparatus: A 60-inch long sandbox was used (Figure 1) to assess the children. Hiding locations ranged from 16 inches to 44 inches longwise.
- Procedure: Written consent was given from the parent and verbal consent from the child. Before the task began there are 6 practice trials in a small, round sandbox. The experimenter hid the toy by placing it on a peg that was buried in the sand, covered it five times, and then the child pointed and uncovered the toy. The toys were hidden either all on the left side or all on the right side at 2 inches, 6 inches, 10 inches, and 14 inches from midline. There are three trials to each hiding location. The order of hiding locations were randomly chosen. The entire session was video-taped and coded afterwards.

Figure 1: Picture of the sandbox in the testing room

Results
- 4 inch Location
- Figure 2: Left Side Location Effect
- Figure 3: Right Side Location Effect
- Figure 4: Away from midline Towards midline

Discussion/Future Directions
- No qualitative shift was found in SWM biases
- This does not support the CA model’s predictions for the transition
- The transition appears to be more gradual which supports the DFT’s predictions
- The 2-inch target location already showed a bias away from midline at 3 years 6 months of age
- Between 3 years 6 months and 3 years 9 months the 4-inch target location transitioned from showing no bias to being biased away from midline
- The 10-inch and 14-inch target locations were still biased toward midline
- This was most evident on the left side of the sandbox
- Most children were right-handed and therefore reach across their bodies
- There were not enough children reaching with their left hands to test for a handedness difference
- May need to be more closely examined in the future
- The only gender difference was seen at the 10 inch location
  - Males were more strongly biased towards midline than females
  - Not sure why this would be the case at just 10 inches
- The bias away from children is already being seen in 3-year-olds
- The transition starts earlier in the sandbox than previously believed
- The transition also depends on target location
- This has now been found both cross-sectionally and longitudinally
- Future longitudinal studies could be done to examine the transition at the other target locations

Figure 2: Left Side Location Effect
Figure 3: Right Side Location Effect
Figure 4: Away from midline Towards midline

References

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