Developmental changes in how children weight spatial information

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Spatial Reference Frames

- ❑ Egocentric by ~8-12 months of age[1]
- ❑ Allocentric
  - Global/room-based by ~18-24 months[2]
  - Intrinsic not until ~5-6 years[3]

What supports use of intrinsic reference frames over development?

Method

- ❑ Four rotation conditions (within-subject); global cues were eliminated by curtains

  <u>Neither Rotate</u>: Maintains alignment of all (best performance[3])

    + Intrinsic + Self + Table + View

  <u>Child Rotate</u>: Mis-aligns egocentric through child's movement 90°

    + Intrinsic + Self − Table − View
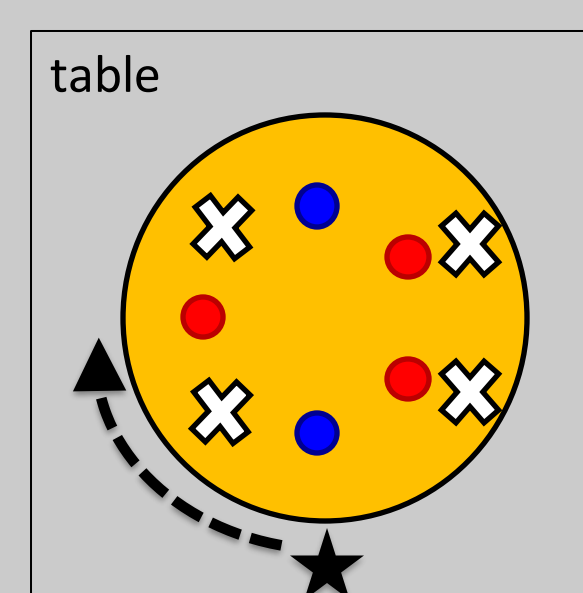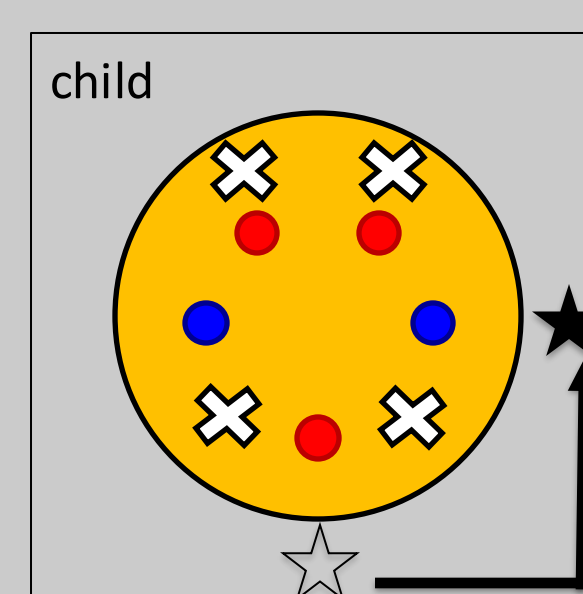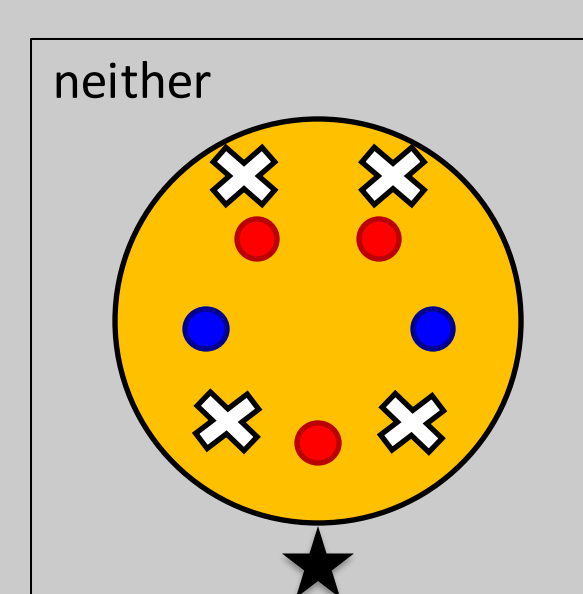
  <u>Table Rotation</u>: Mis-aligns egocentric and room-centered through table's movement -90° (worst performance[3])

    + Intrinsic − Self + Table − View

  <u>Both Rotate</u>: Re-aligns egocentric through both child's and table's movement 90°
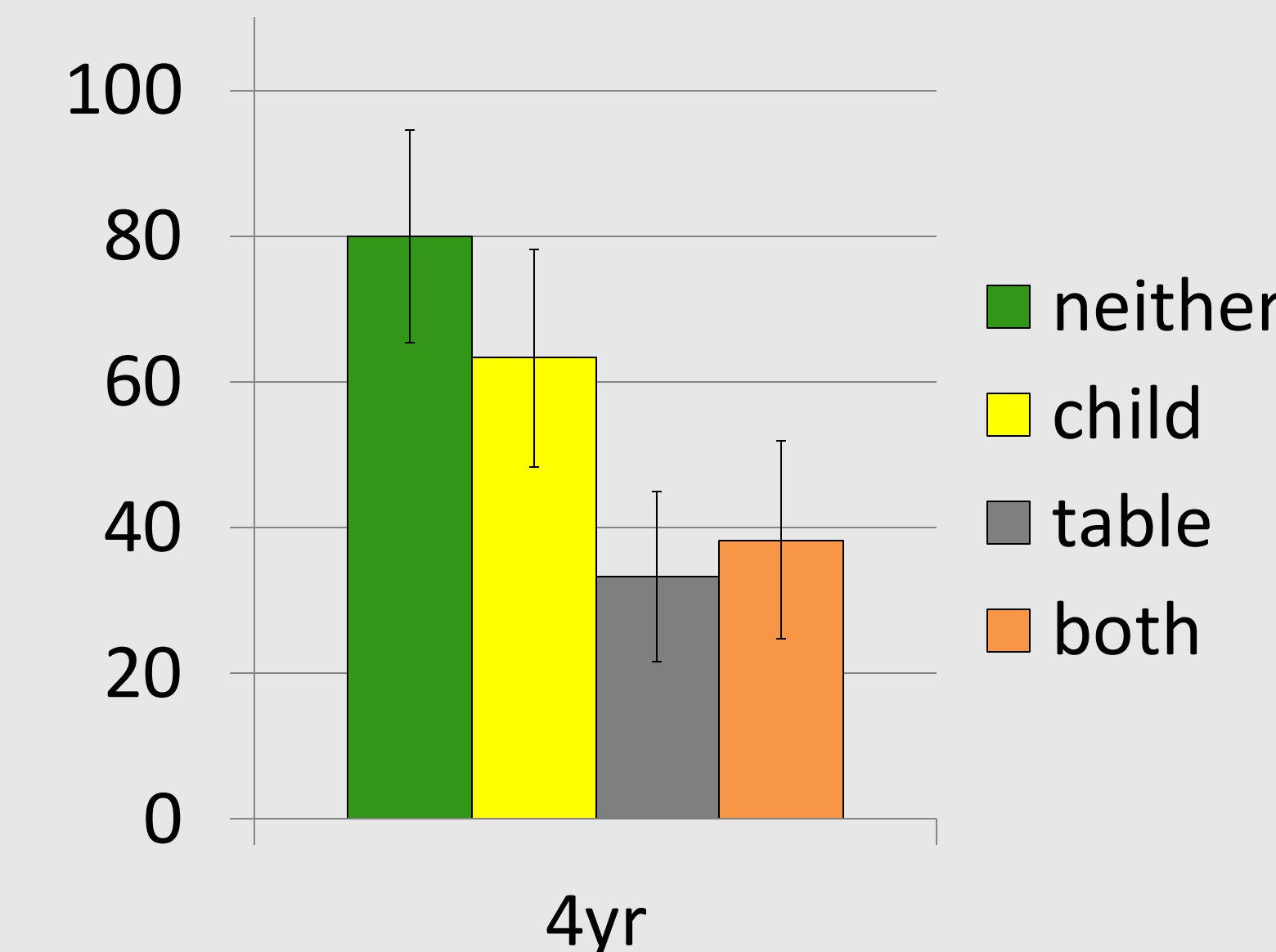
    + Intrinsic − Self − Table + View

- ❑ Compare across rotation types to assess weighting of reference frames and other available information
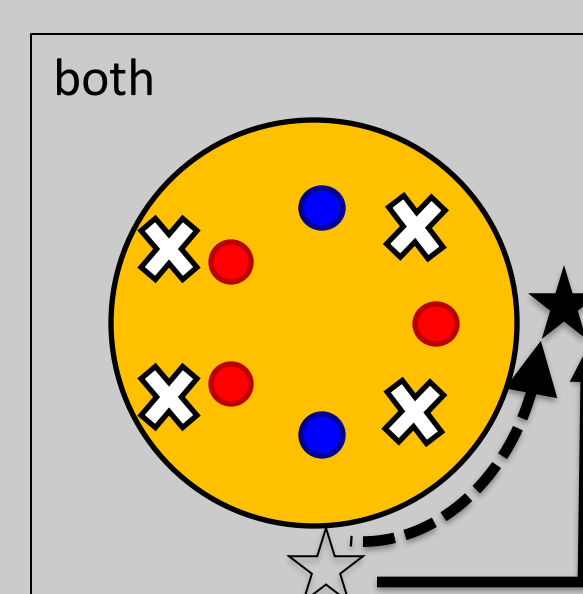
## Experiment 1: What changes in children's performance over development?

- ❑ Twenty 4-year-olds
- ❑ Rotation effect:
  Neither > Child > Both/Table
- ❑ Model fit (MAE = 2%)
  - Same weighting fit across all four rotation types
  - Some use of intrinsic (> 0)
  - Most weight on self movement = known change (proprioception, egocentric updating)

- ❑ Twenty 6-year-olds
- ❑ Rotation effect:
  Neither > Child/Both/Table
- ❑ Model fit (MAE = 1%)
  - Modified by rotation type
  - Most weight on intrinsic
  - Weighted factors based on relevance
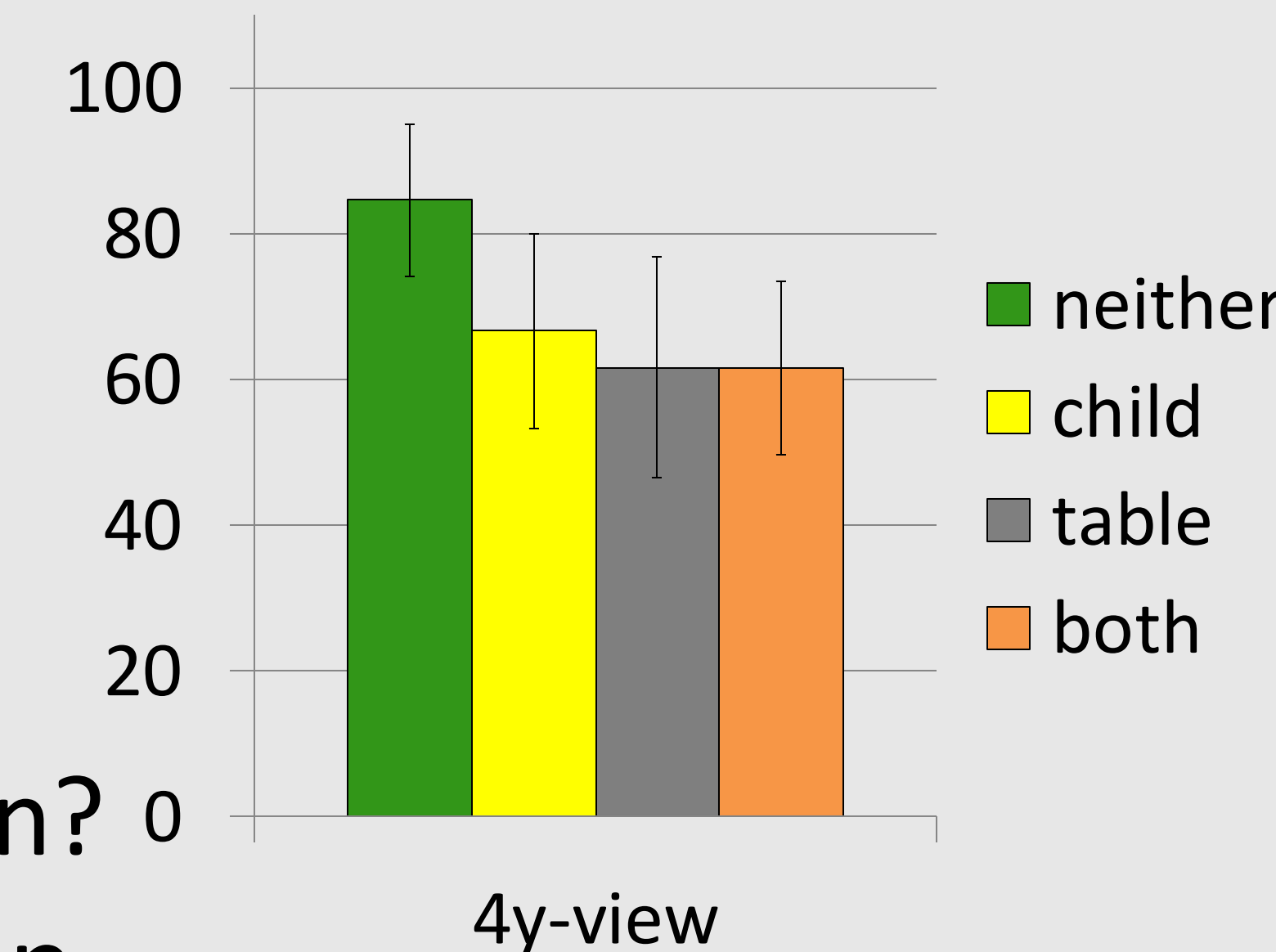- ❑ Development: weight intrinsic most, adapting across rotation types

Heatmap of Model Weights

E1 - 4y	intrinsic	self	table	view	cup color	uncertainty
neither	20	35	10	10	15	10
child	20	35	10	10	15	10
table	20	35	10	10	15	10
both	20	35	10	10	15	10
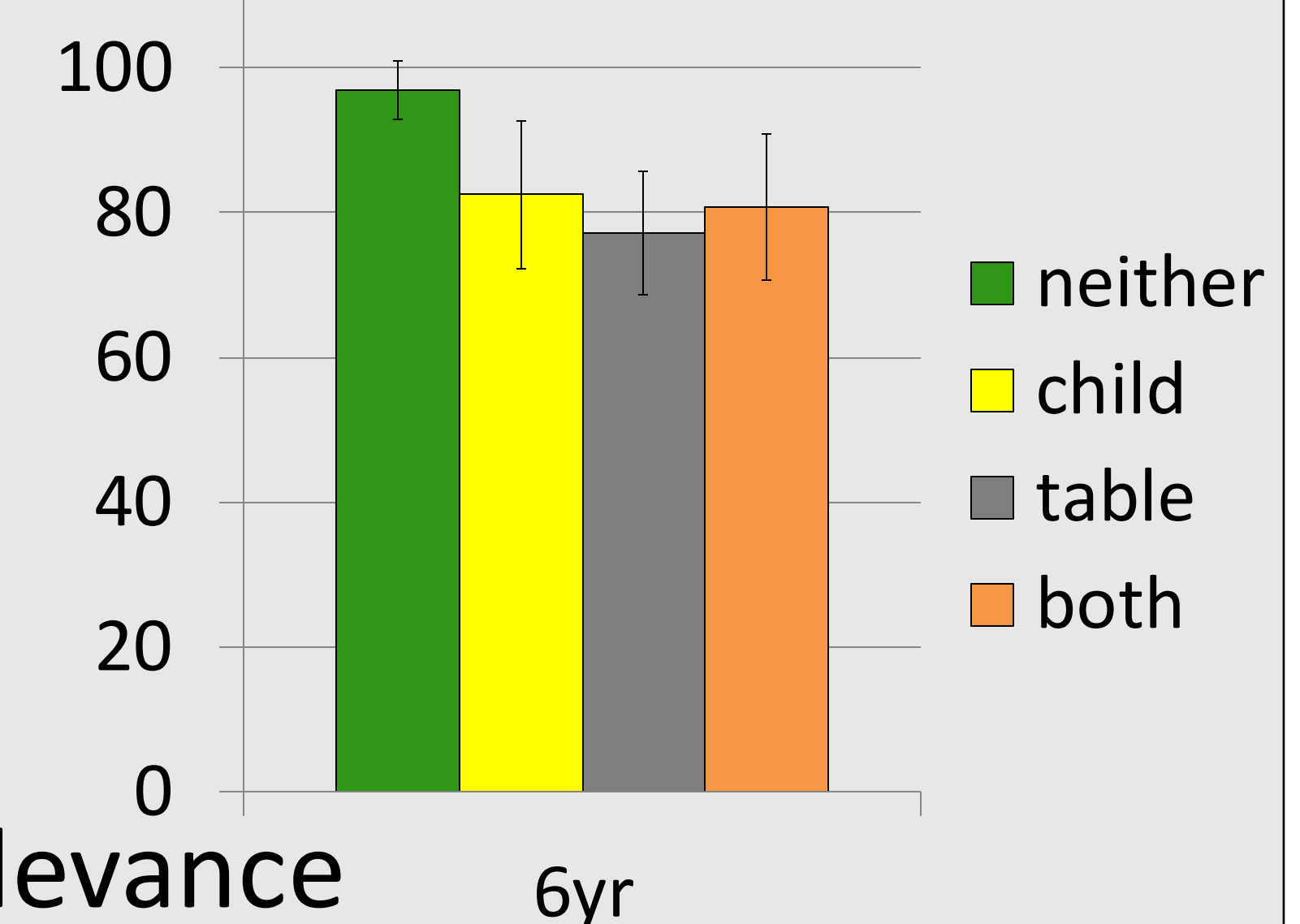
Heatmap of Model Weights

E1 - 6y	intrinsic	self	table	view	cup color	uncertainty
neither	65	5	5	20	5	0
child	65	15	5	5	5	5
table	65	5	12	5	5	8
both	65	5	5	14	5	6

Experiment 2: Can we help 4-year-olds perform like older children by providing more information about the changes across trials?

- ❑ Twenty 4-year-olds; <u>view all changes</u>
- ❑ Rotation effect
  Neither/Child > Both/Table
- ❑ Model fit (MAE = 3%)
  - Modified by rotation type, similar to 6-year-olds
  - Simply fixating hiding location?
- ❑ Tested in follow-up condition

- ❑ Twenty 4-year-olds; <u>view with cups occluded</u>
- ❑ Rotation effect
  Neither/Child/Both > Table
- ❑ Model fit (MAE = 1%)
  - Modified by rotation type, but not as effectively
  - *Disrupted intrinsic frame*
- ❑ Different pattern than Exp1 or 2a

Heatmap of Model Weights

E2a	intrinsic	self	table	view	cup color	uncertainty
neither	35	10	10	25	15	5
child	35	25	10	10	15	5
table	35	10	23	10	15	7
both	35	10	10	23	15	7
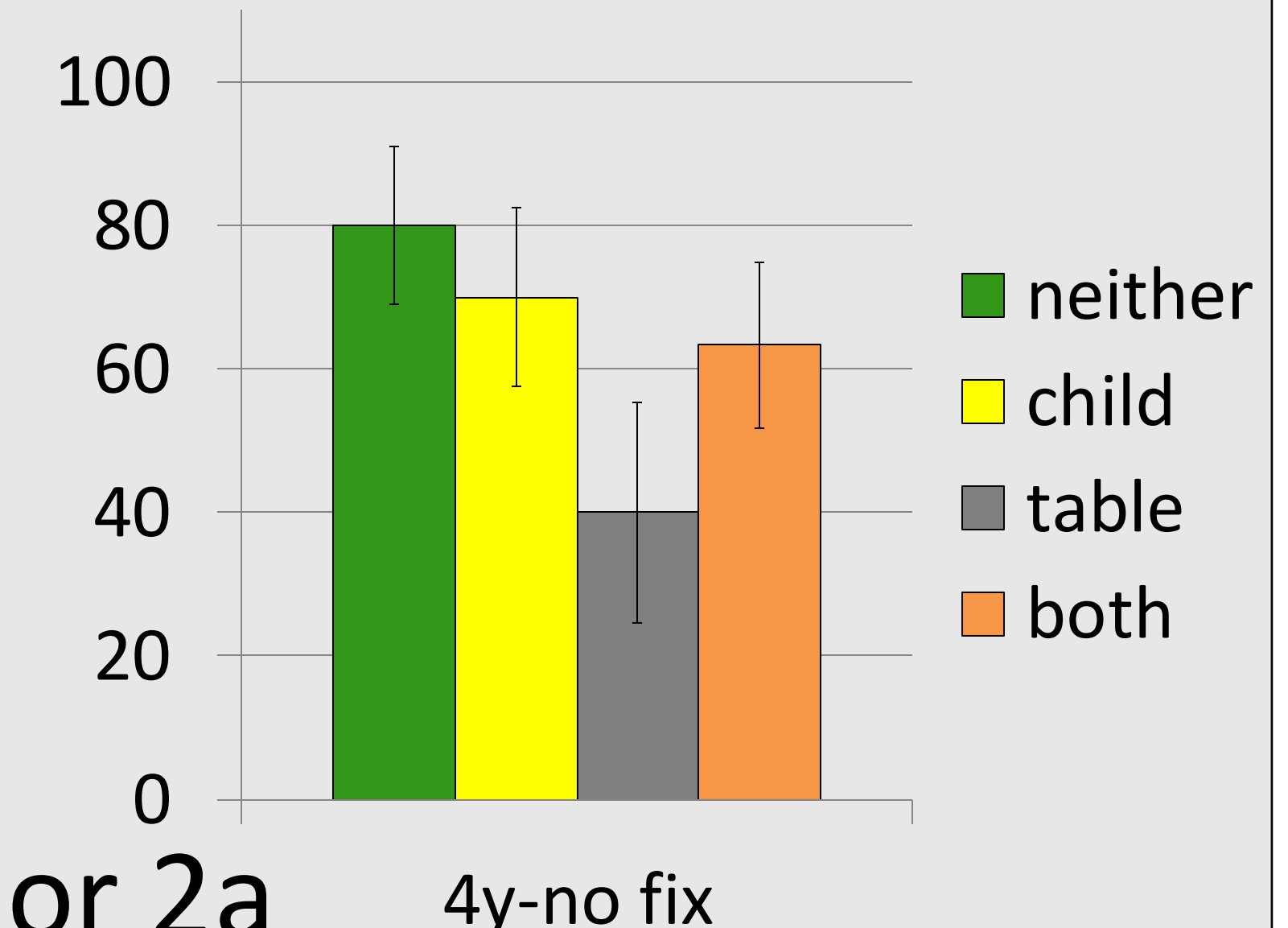
Heatmap of Model Weights

E2b	intrinsic	self	table	view	cup color	uncertainty
neither	20	10	10	30	15	15
child	20	40	5	5	15	15
table	20	18	12	18	15	17
both	20	10	10	30	15	15

Model of Children's Weighting

Likelihood of finding hidden toy based on factors separately

	cup color	intrinsic	self movement	table movement	view at hiding	front search (uncertainty)
neither	0.398	1	1	1	1	0.2
child	0.398	1	1	0	0	0.2
table	0.398	1	0	1	0	0.2
both	0.398	1	0	0	1	0.2

Weighting Details

- ❑ Adjusted to fit sequentially as needed: 1) neither, 2) table, 3) child, 4) both
- ❑ Only self, table, view, and uncertainty could vary across rotation types
- ❑ Mean absolute error (MAE) calculated across rotation types for each exp/age separately

Conclusions

- ❑ Young children may use an intrinsic reference frame, but weight other information more
- ❑ Knowledge of self vs. table movement differs
- ❑ Viewing table movement supports performance
- ❑ Occluding cups disrupted intrinsic reference frame