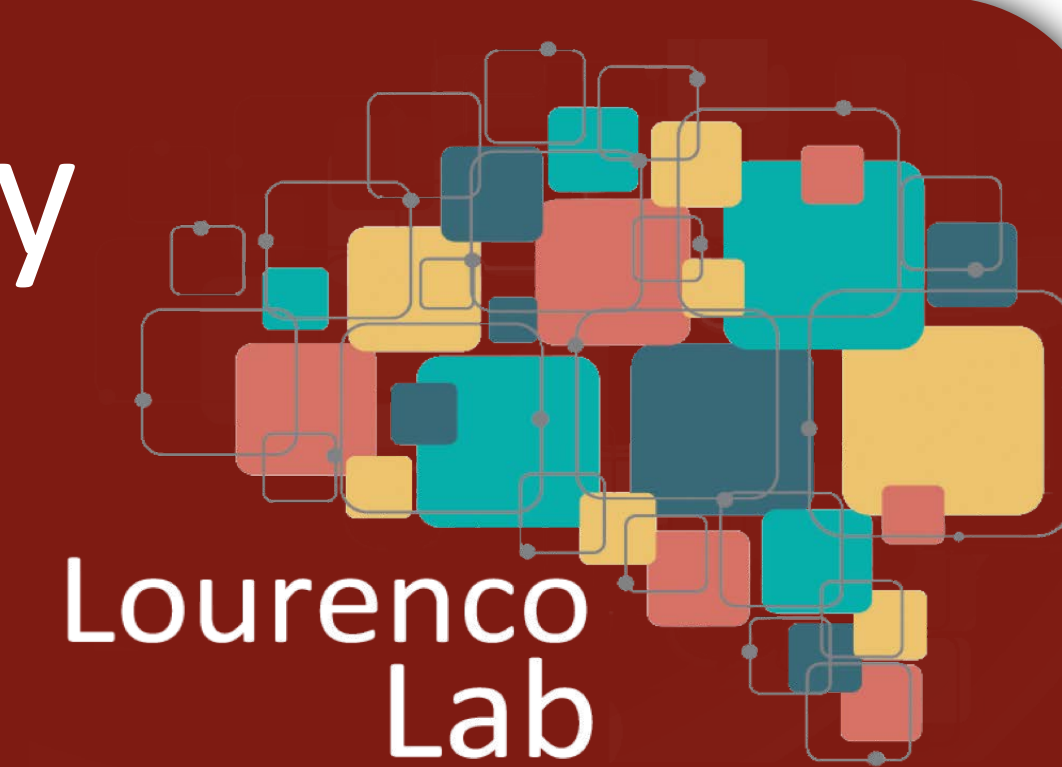




Children, adults, and machines use the geometric centroids of objects to judge physical stability

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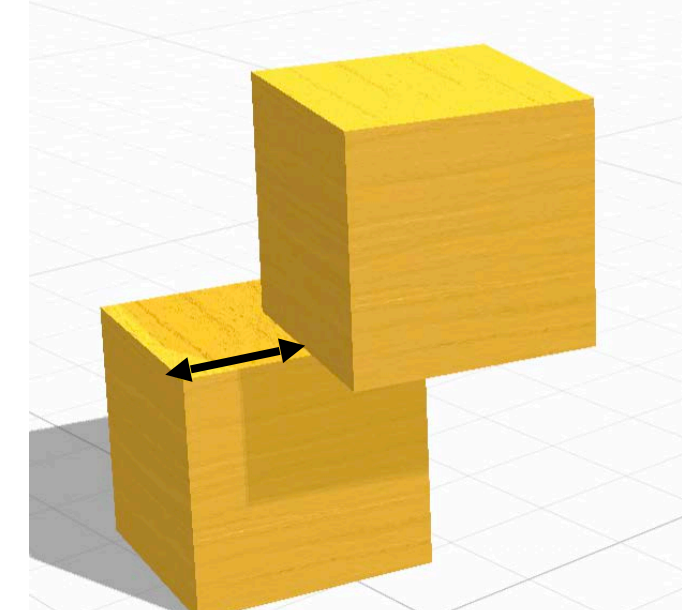
Intuitive Physics



Humans are highly sensitive to the physical stability of objects¹
Such intuition emerges early in infancy²
Yet the perceptual mechanisms remain unknown

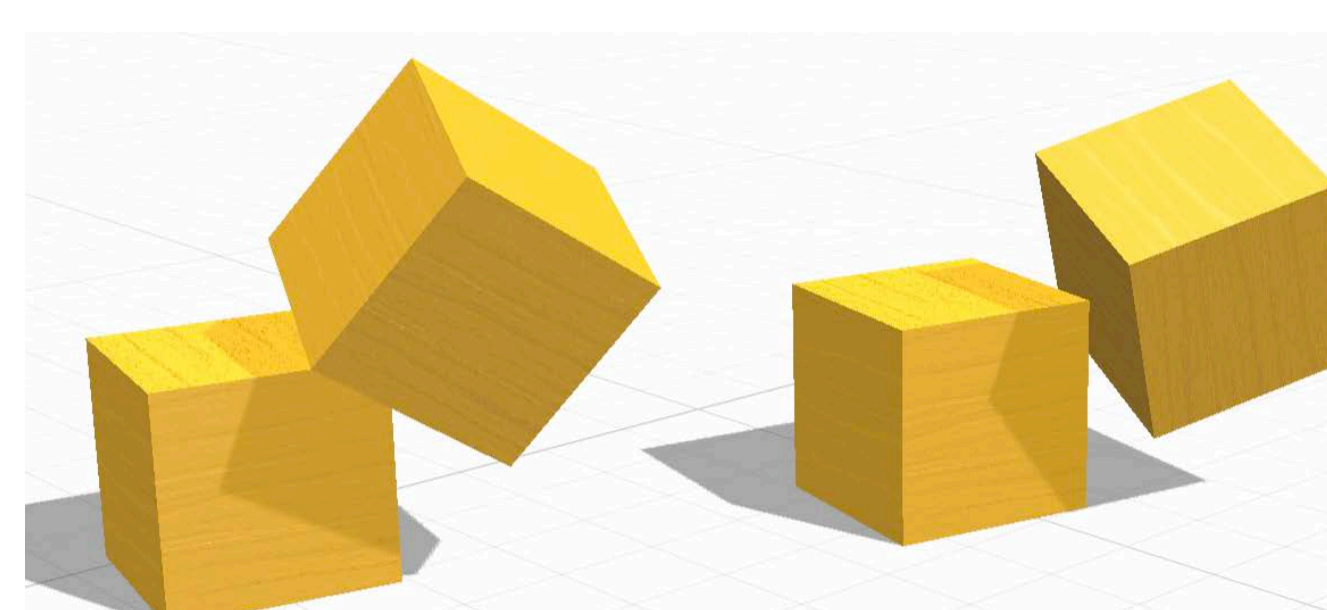
Will it fall? Two theories

Rule-learning²



Proportion rule:
more than half? Fall

Mental simulation³



10 quick runs, 7 falls:
likely to fall

We propose a perceptual model in which perceptual inputs (i.e., geometric centroids) are extracted and used for stability judgments, serving as a perceptual basis (or alternative) for these two accounts

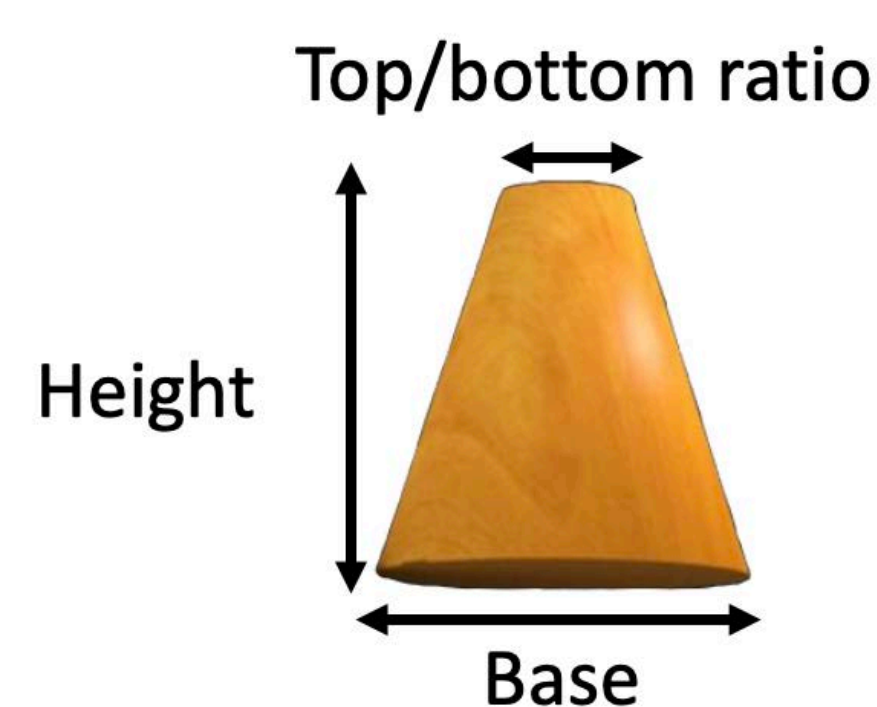
What is a perceptual model?

Geometric centroid



Geometric centroid

Non-centroid features

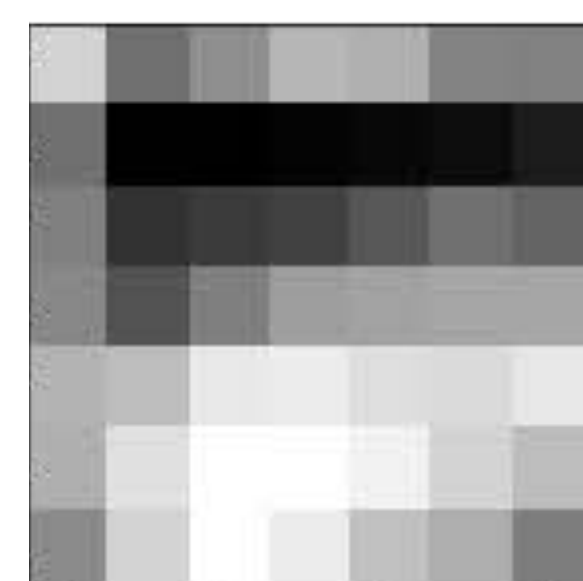


Height

Top/bottom ratio

Base

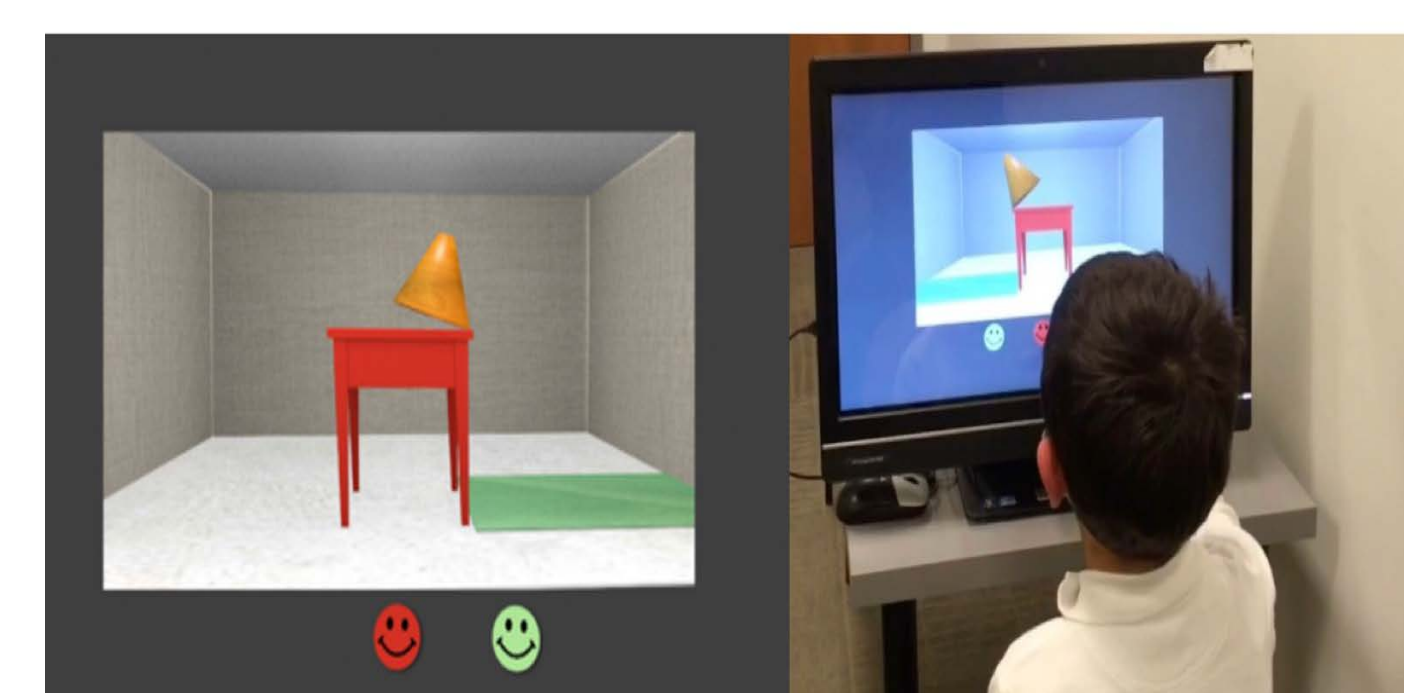
Image-based (CNN)



Which model mostly aligns with human performance?

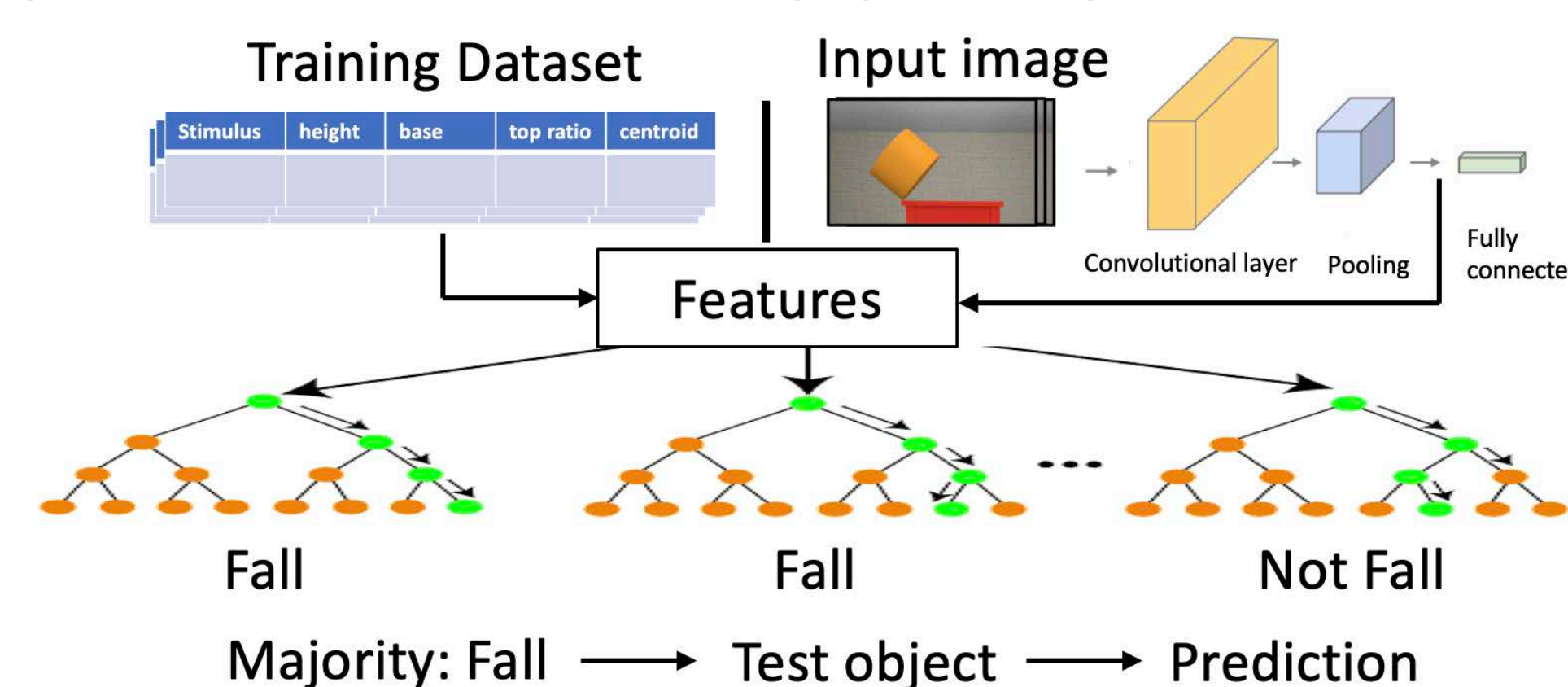
Task and Experiments

Children (6 yrs) & Adults



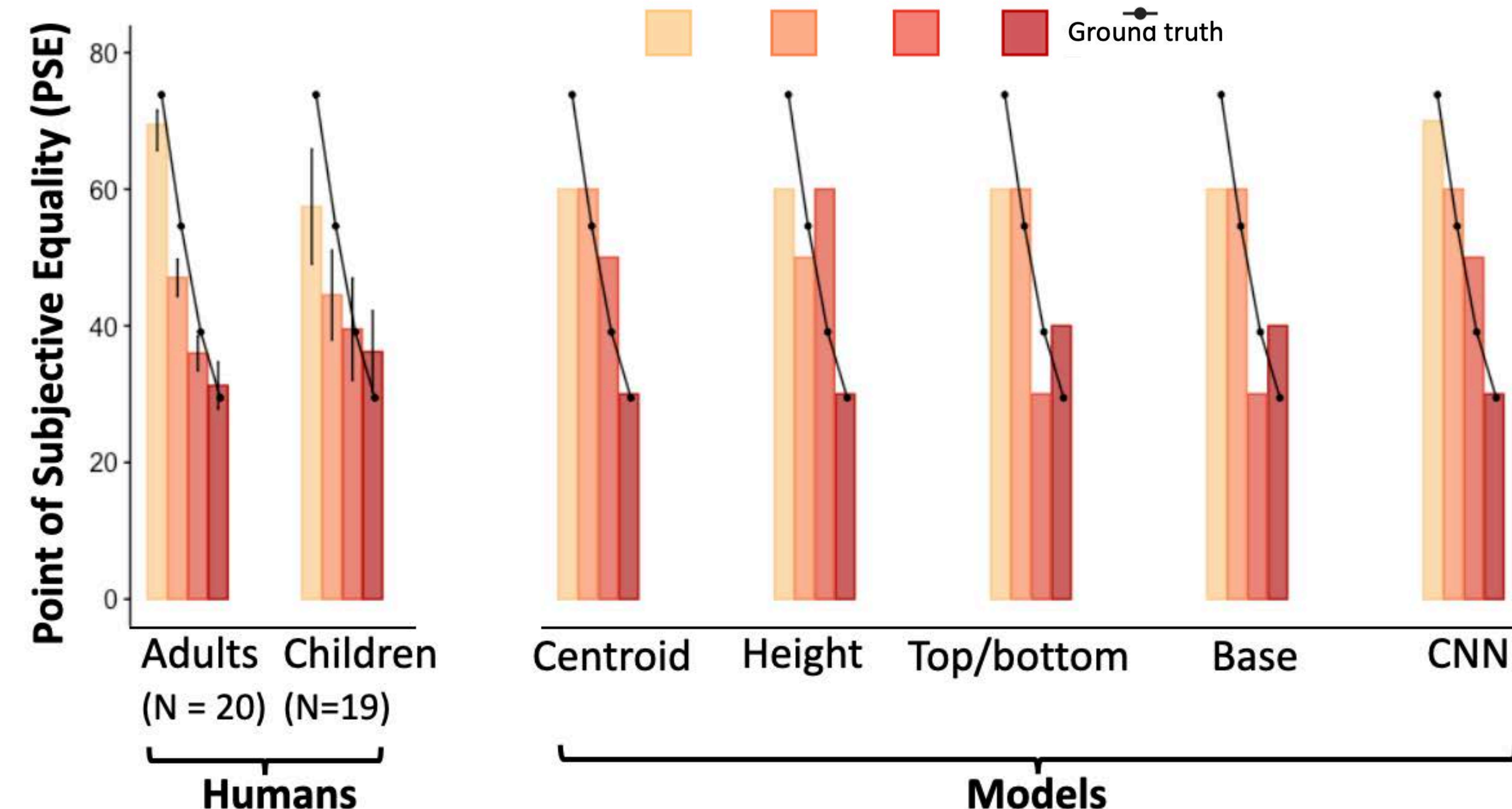
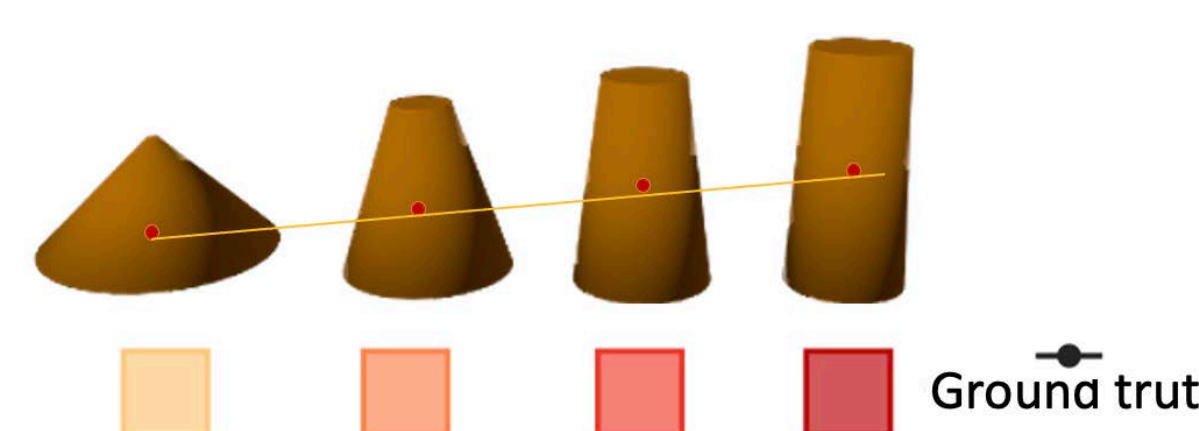
“Stay on the red table or fall onto the green floor?”

Machine



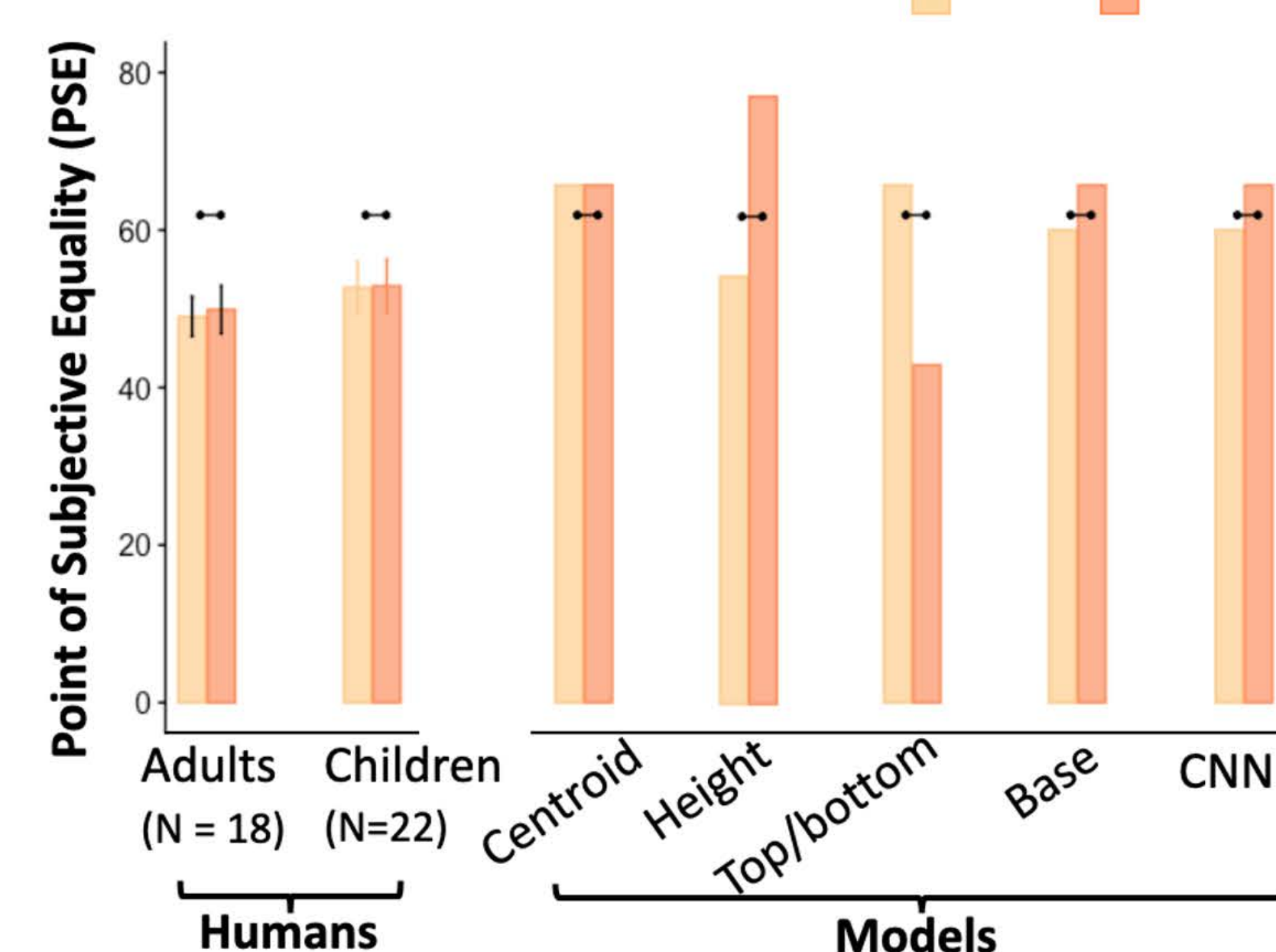
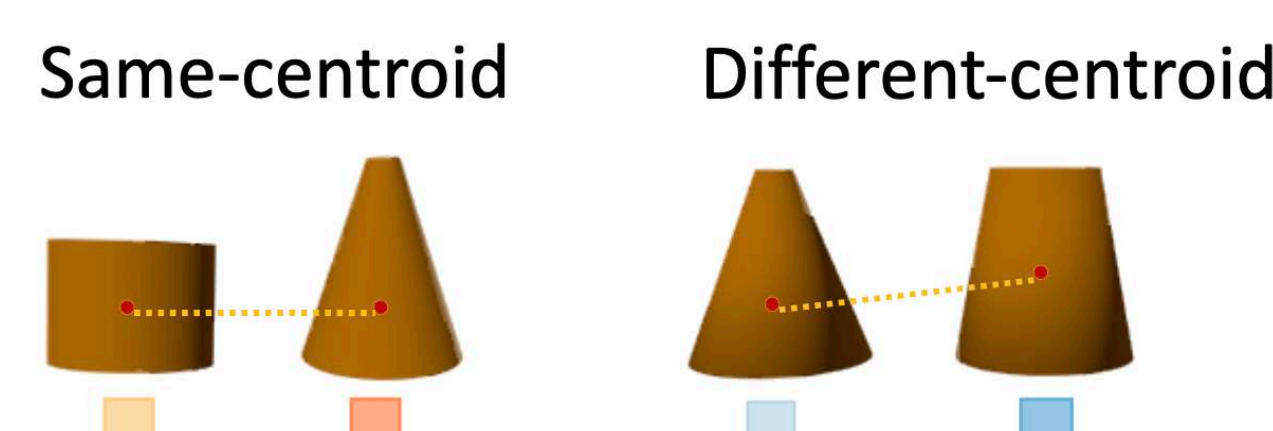
Random forest classifier

Experiment 1



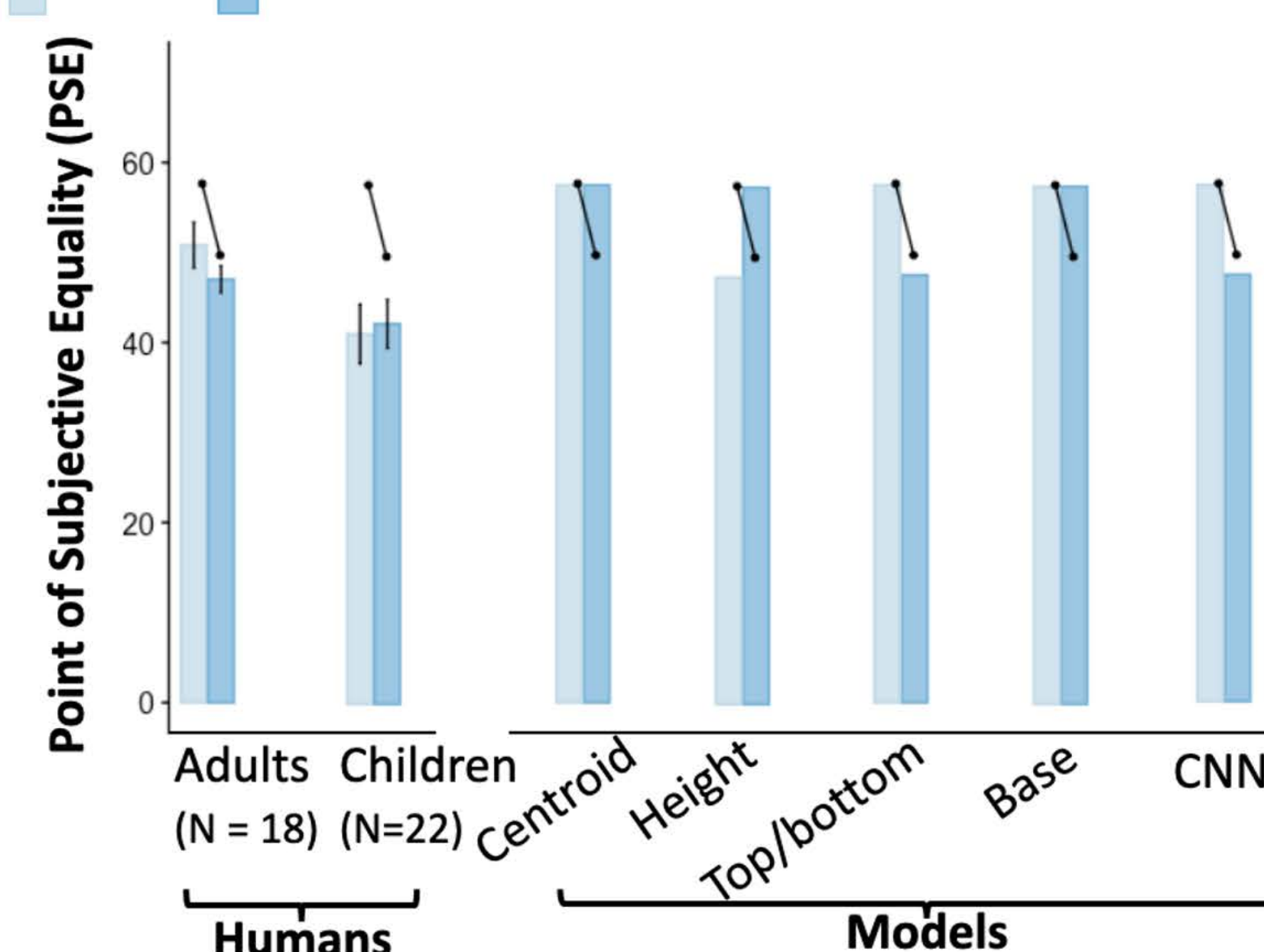
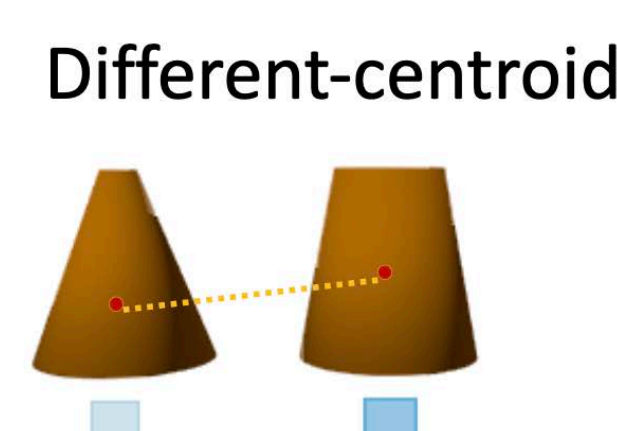
Centroid and CNN models are mostly aligned with humans

Experiment 2A



Centroid model is mostly aligned with humans

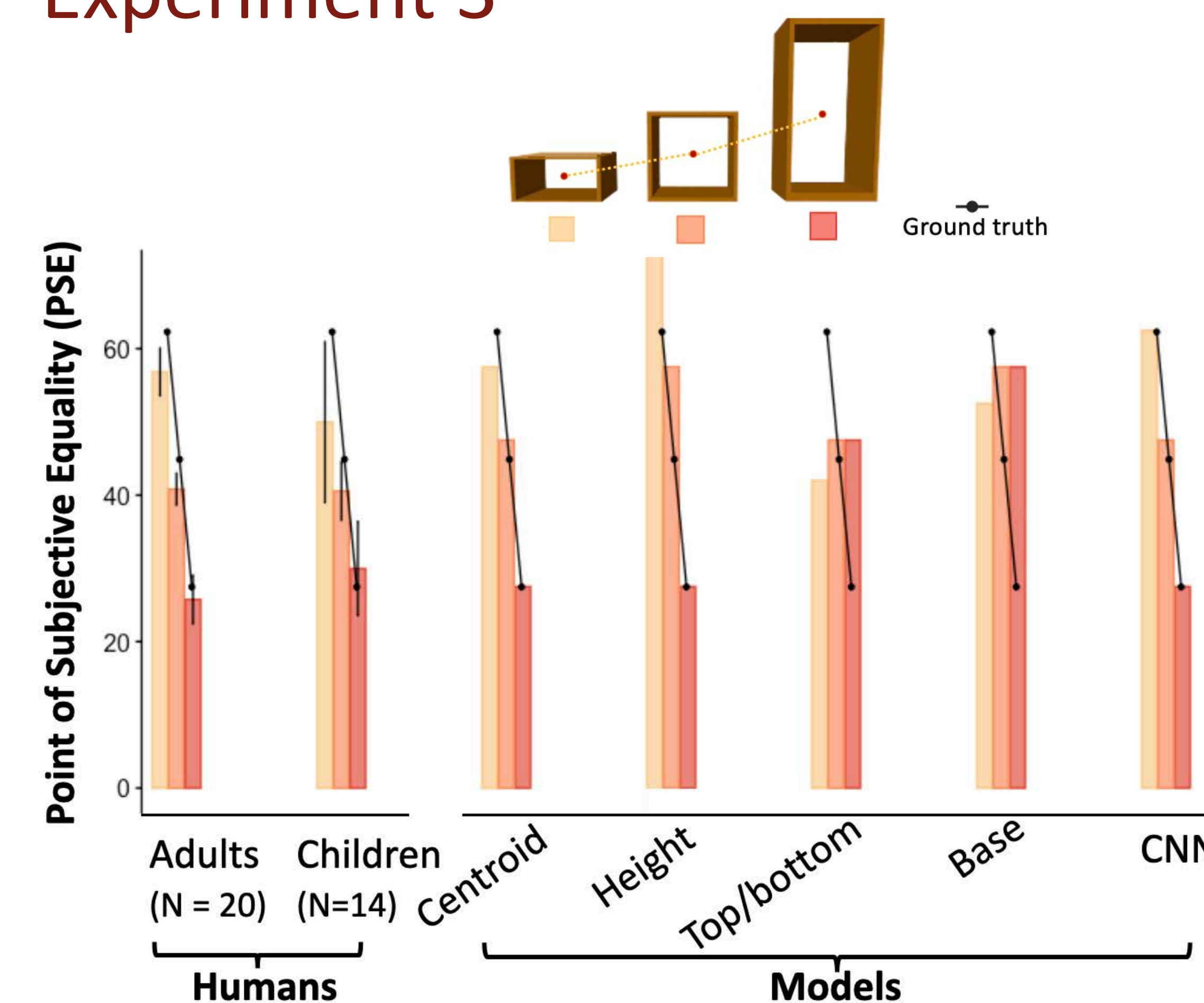
Experiment 2B



Less clear cut which model aligns best with humans

Experiments (continued)

Experiment 3



Centroid and CNN models are mostly aligned with humans

Summary and Conclusions

- Children’s estimates were comparable to those of adults, though they were less precise
- Across experiments, centroid and CNN models were most closely aligned with children’s and adults’ estimates, consistent with a perceptual model
- Caveat: Models performed worse when multiple features were available or discriminability between objects was low
- Rule-learning and mental simulation accounts may not be needed for stability judgments—a perceptual model may be sufficient

Acknowledgments

We thank Anna Bulka and Soye Han for their assistance with data collection.

References

- 1.Firestone & Frank (2016). JEP:General
- 2.Needham & Baillargeon (1993). Cognition
- 3.Battaglia, Hamrick, & Tenenbaum (2013). PANS