



Probing nonhuman primate errors on false belief tasks to explore the evolutionary roots of Theory of Mind

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Motivation

Both nonhuman primates and human infants perform inconsistently on implicit false belief tasks – sometimes passing and sometimes showing null performance (e.g., 1, 2, 3, 4).

How can we explain null performance on nonverbal false belief tasks?

Two possible explanations...

Multiple Predictions

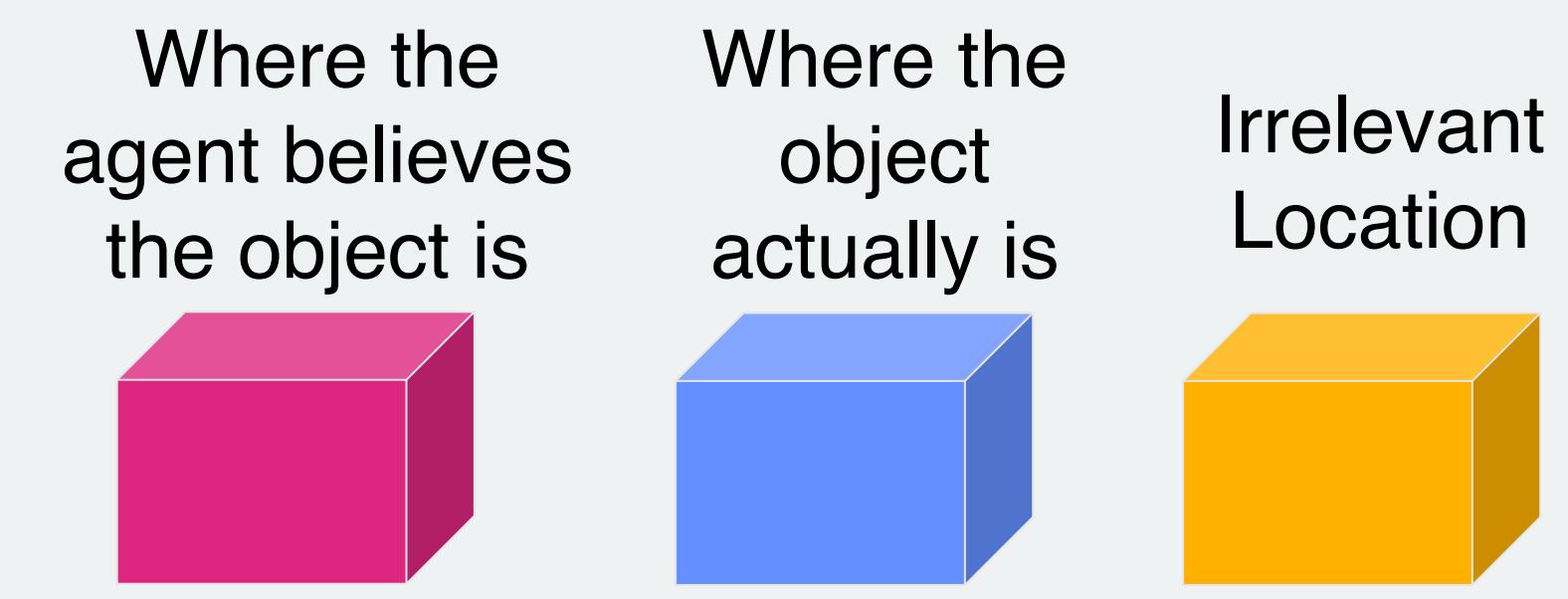
Subjects make multiple predictions consistent with all outcomes tested in typical false belief studies

No Prediction

Subjects form no predictions and thus have no expectations which could be violated by tested outcomes

Design

Using a third location to understand null performance



Multiple Predictions

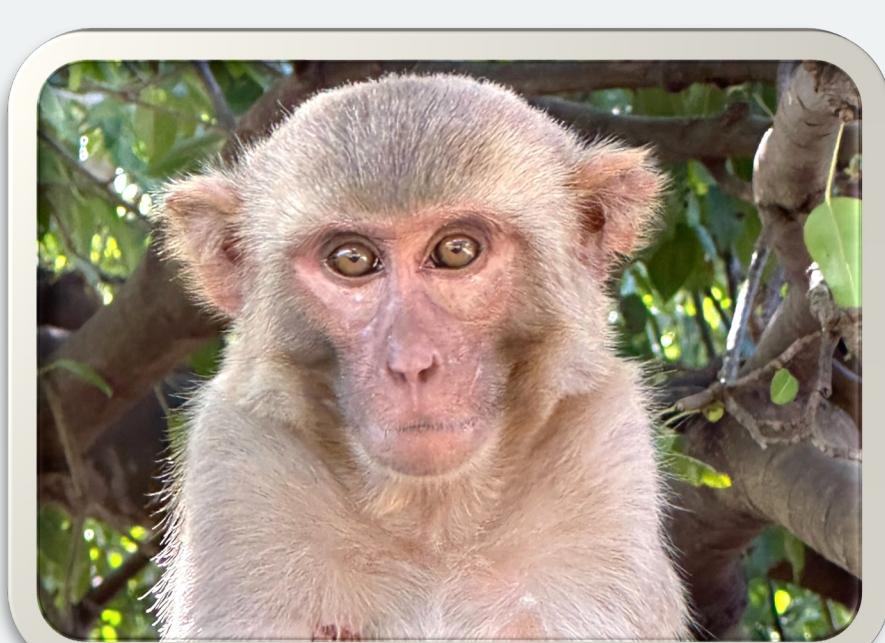


Subjects should show longer looking times for an action that is inconsistent with their predictions

No Prediction



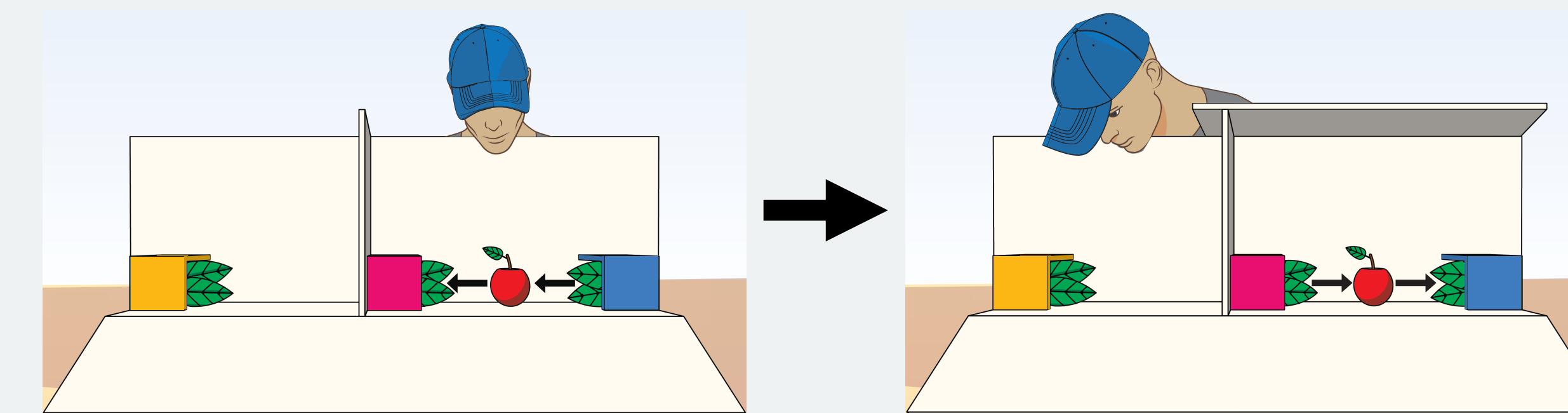
Subjects should show no difference in looking times since they have no expectations to be violated



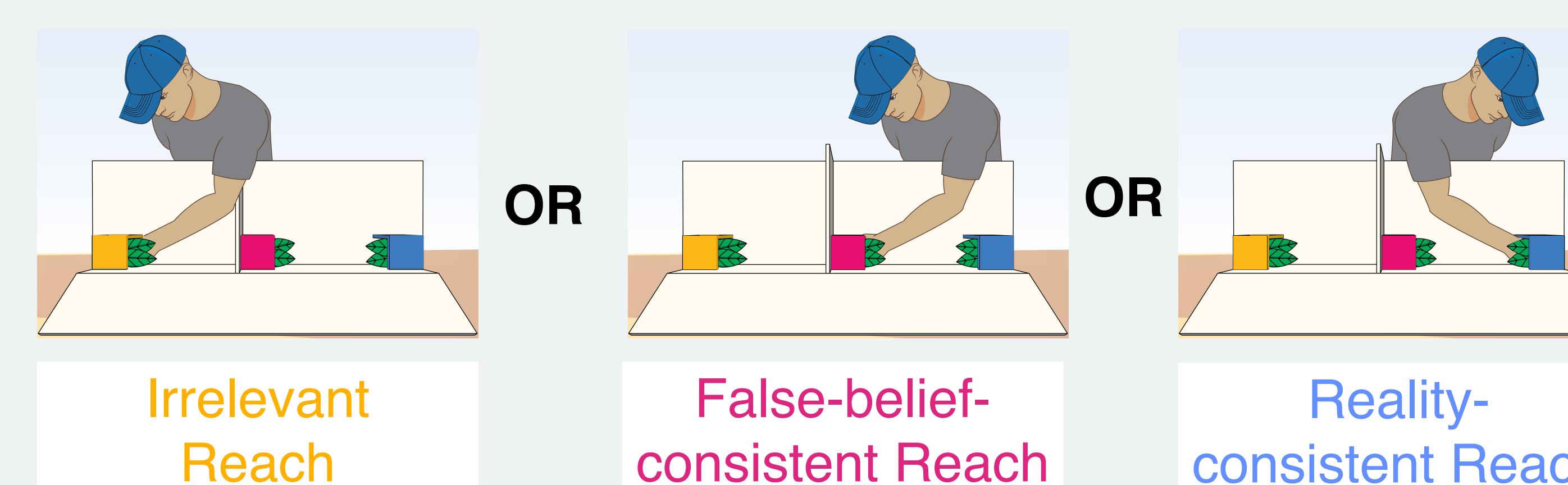
Study 1

Monkeys do not look longer at a reach to an irrelevant location in a false belief task

Belief Induction Event:



Final Outcome:

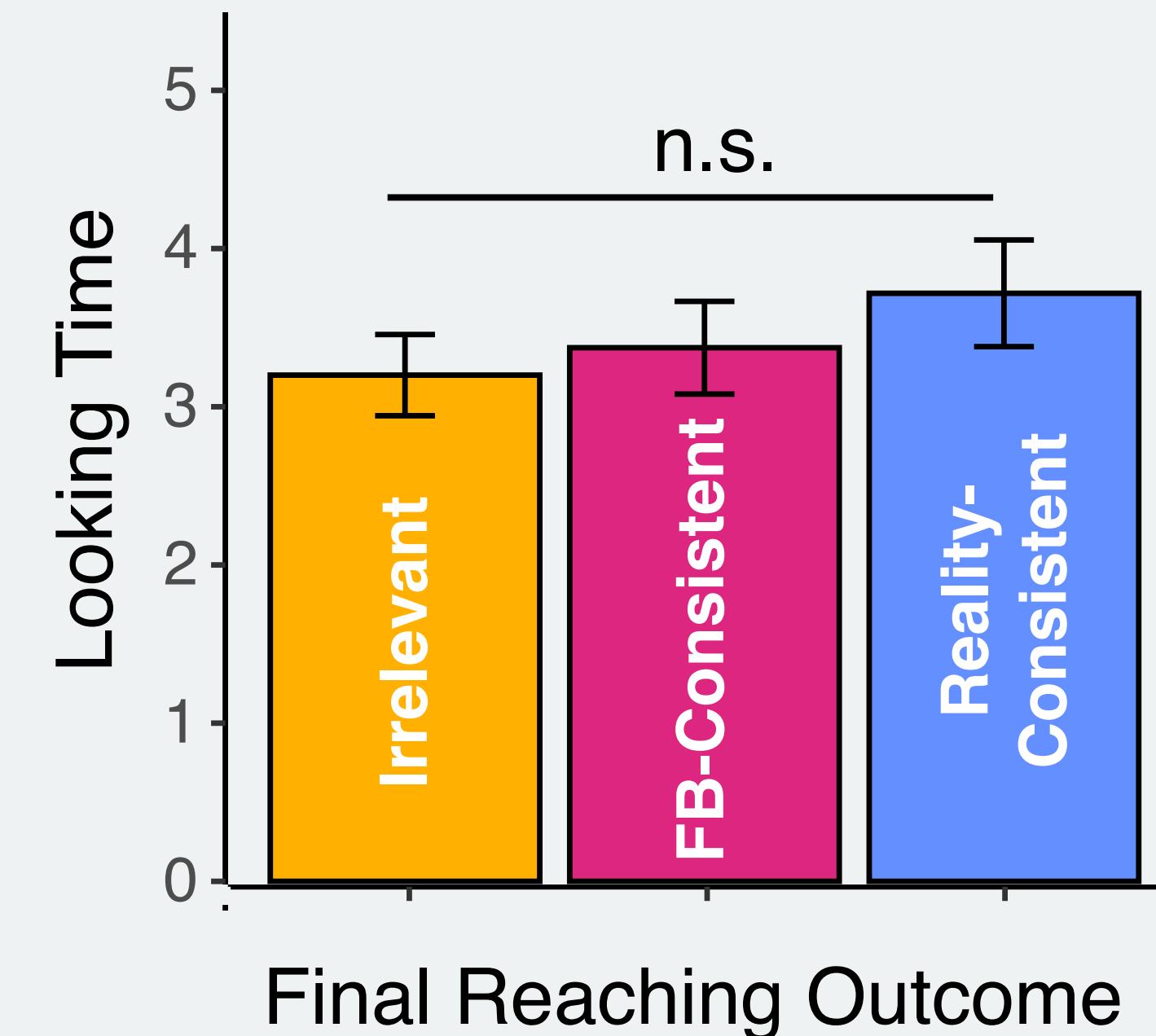


n = 148 rhesus macaques

Looking change relative to Irrelevant Reach:

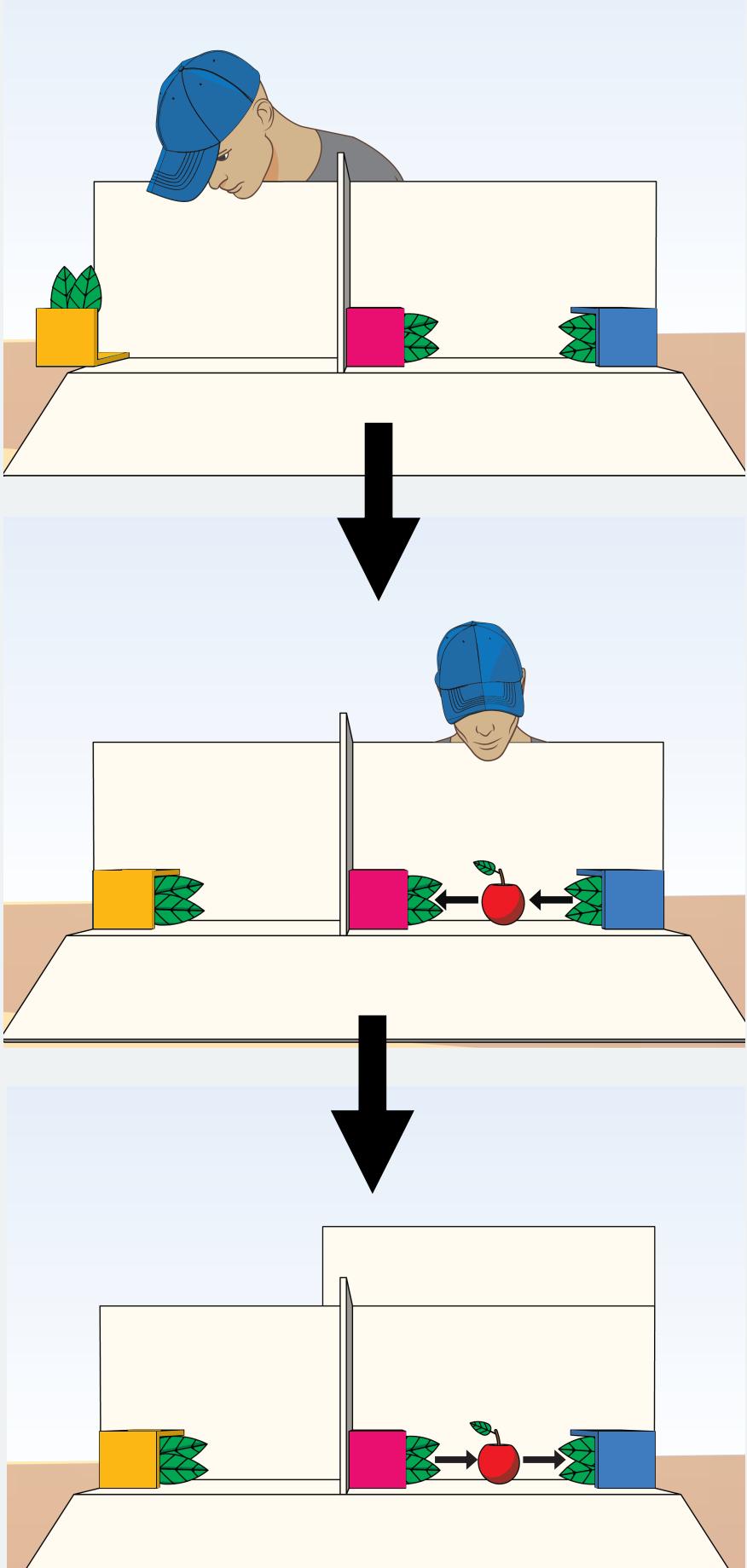
$$\beta_{FB\text{-consistent}} = -0.01, p = .917$$

$$\beta_{Reality\text{-consistent}} = 0.15, p = .249$$



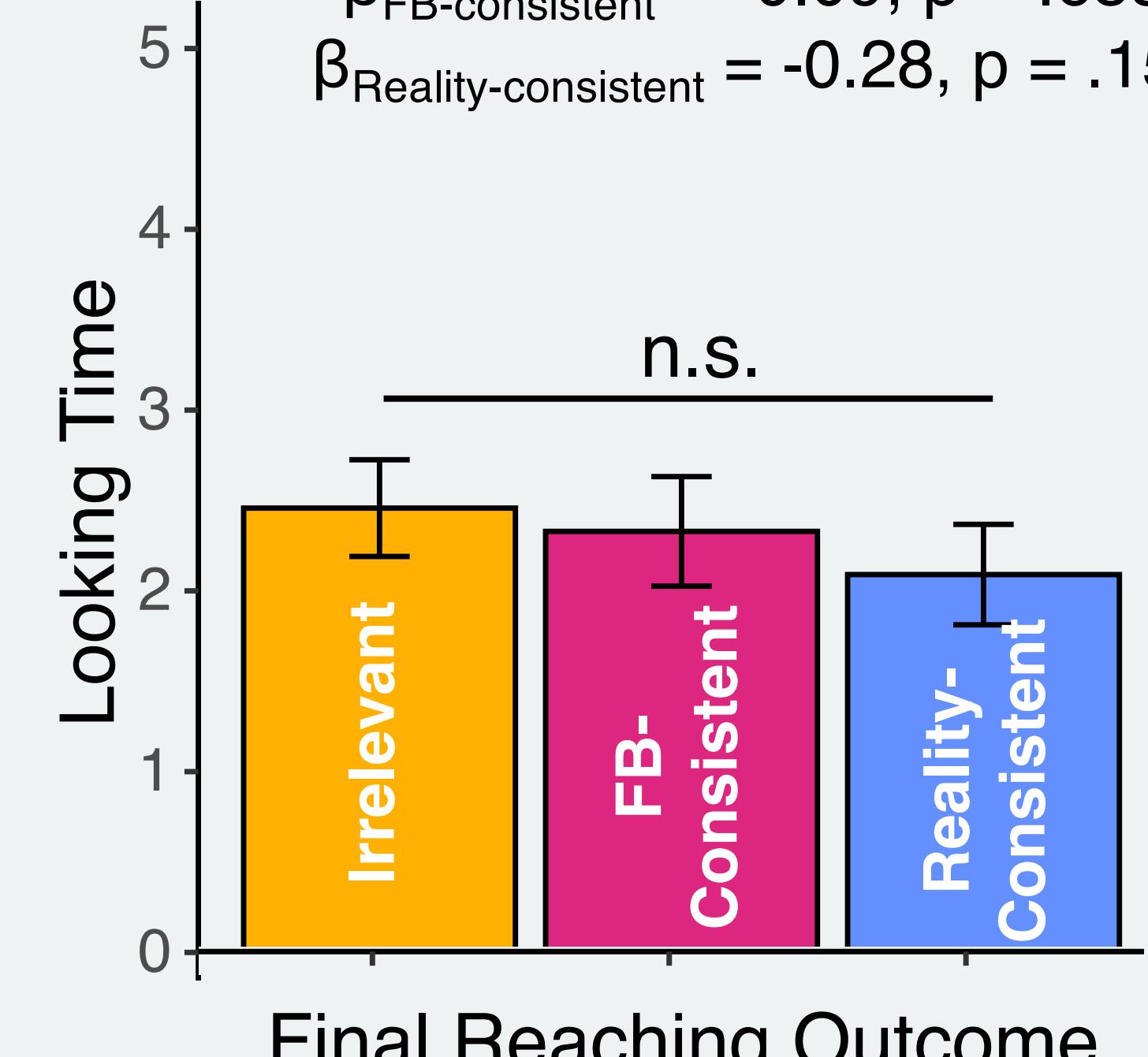
Study 2

Monkeys do not look longer at a reach to an irrelevant reach even when the box is shown to be empty



n = 121 rhesus macaques

Looking change relative to Irrelevant Reach:
 $\beta_{FB\text{-consistent}} = -0.09, p = .653;$
 $\beta_{Reality\text{-consistent}} = -0.28, p = .157$

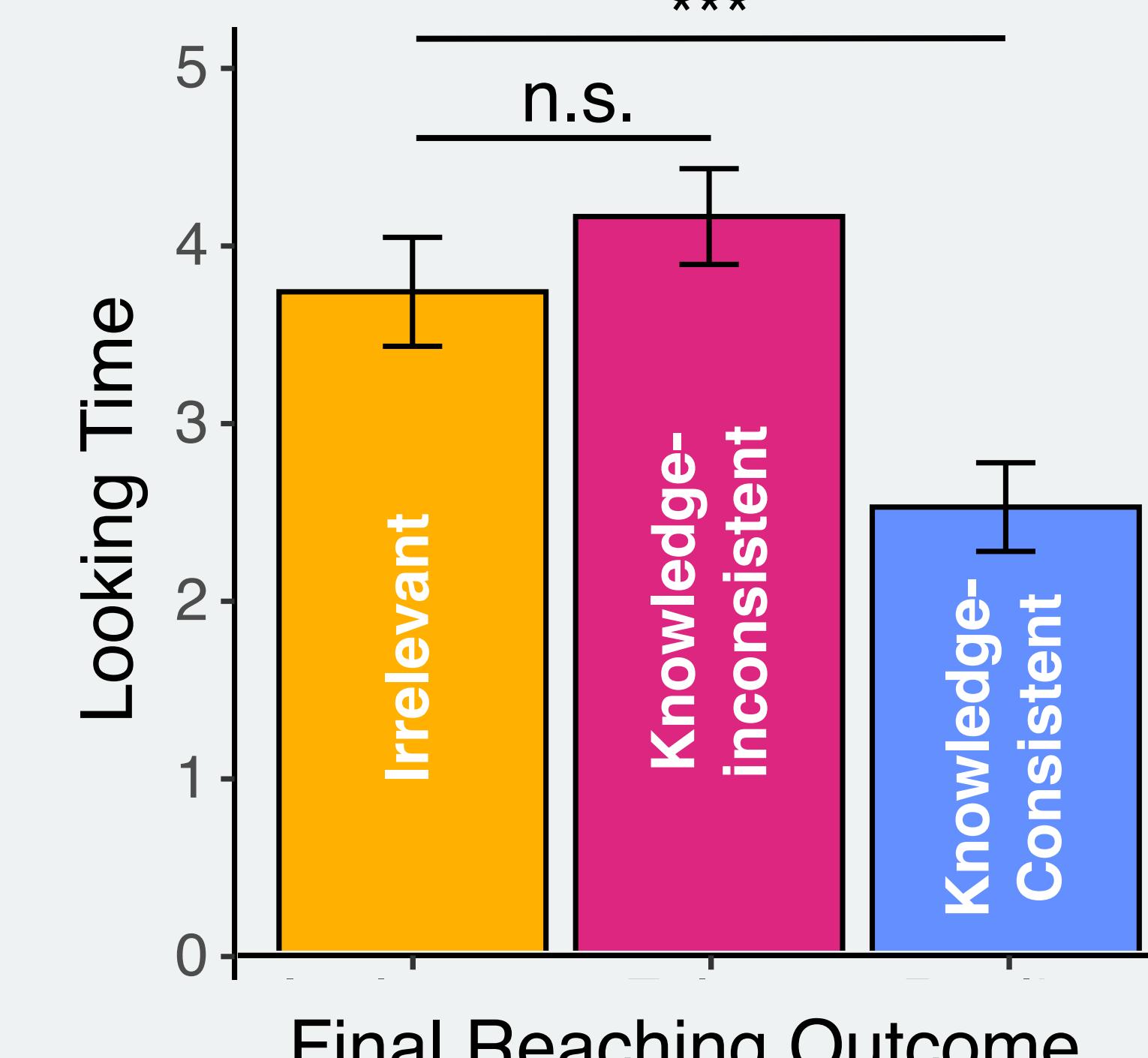
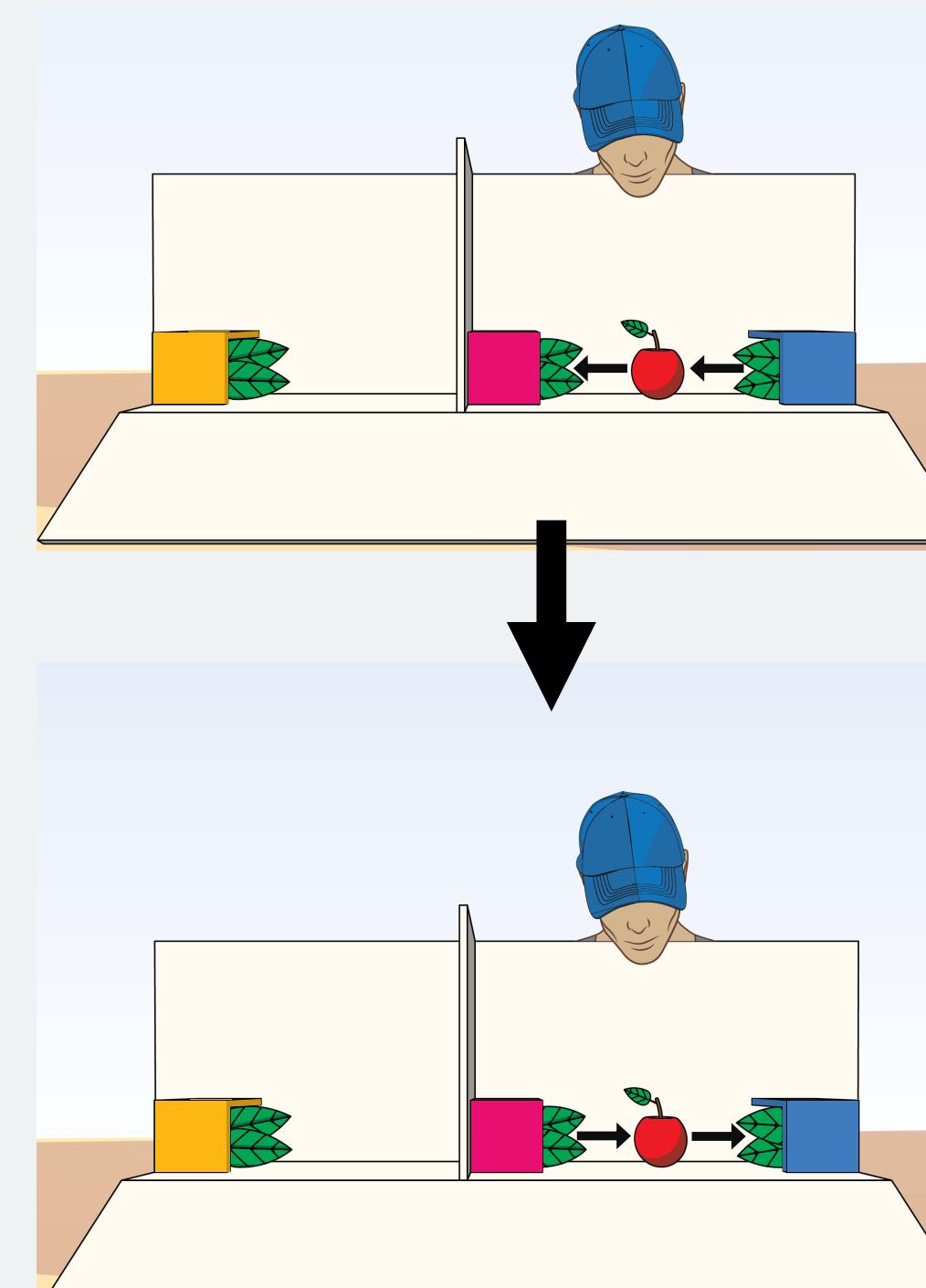


Study 3

Monkeys can make accurate predictions about a knowledgeable agent in a similar set-up

n = 150 rhesus macaques

Looking change relative to Knowledge-Consistent Reach:
 $\beta_{Irrelevant} = 0.53, p < .001;$
 $\beta_{Knowledge\text{-inconsistent}} = 0.63, p < .001$



Conclusions and Future Directions

- In false belief tasks, rhesus macaques fail to show a “violation of expectancy” looking response
 - Even when a demonstrator with a false belief reaches to an irrelevant location
- This is consistent with our “No Prediction” account
- Nonhuman primates may fail false belief tasks because they do not actively make predictions when agents do not have accurate representations of the world
- Future work should test whether human infants show a similar pattern of performance

References

- Krupenye, C., Kano, F., Hirata, S., Call, J., & Tomasello, M. (2016). *Science*.
- Marticorena, D. C. W., Ruiz, A. M., Mukerji, C., Goddu, A., & Santos, L. R. (2011). *Developmental Science*.
- Southgate, V., Senju, A., & Csibra, G. (2007). *Psychological Science*.
- Powell, L. J., Hobbs, K., Bardis, A., Carey, S., & Saxe, R. (2018). *Cognitive Development*.