

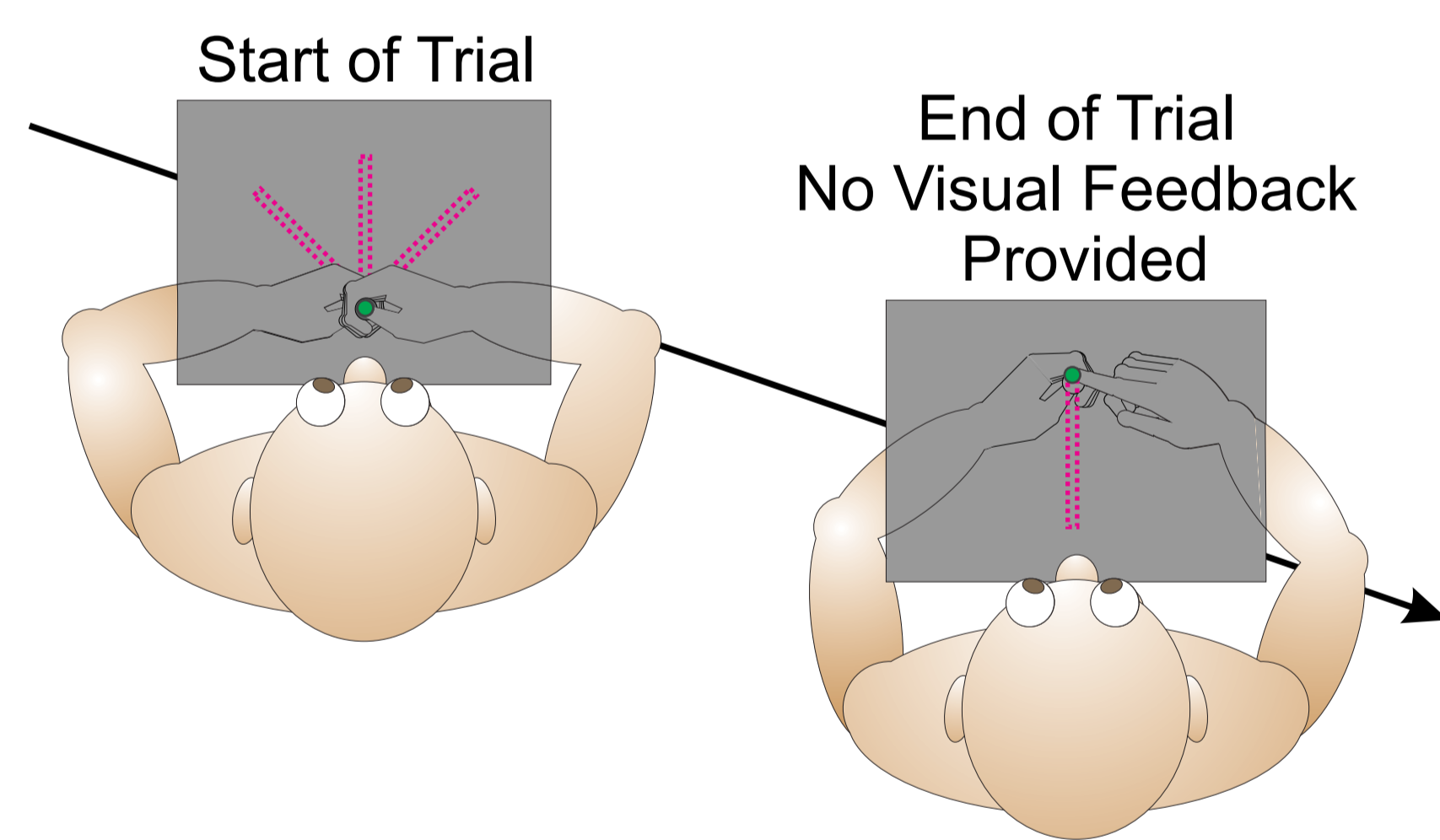
INTRODUCTION

Our central nervous system (CNS) uses both visual and proprioceptive information about the locations of our body parts to enable us to move throughout the environment and complete our daily activities. According to optimal integration theories (e.g. Ernst and Banks, 2002; van Beers et al., 2006), when the brain encounters multiple sources of sensory information regarding an object's location (e.g. visual and proprioceptive information indicate the location of one's hand), the brain combines these multiple sensory inputs to form a coherent estimate of the object's location in such a way that the more reliable sensory input is assigned a greater weight. In the present research we asked if the motor system can learn to change the way in which it integrates sensory signals when reaching to a multisensory target.

METHODS

To determine if the brain can change the way it integrates sensory information, we examined subjects' reaches to multisensory targets (targets defined by both vision and proprioception, **VP**), after they practiced reaching to visual (**V**) and proprioceptive (**P**) targets with inaccurate endpoint visual feedback.

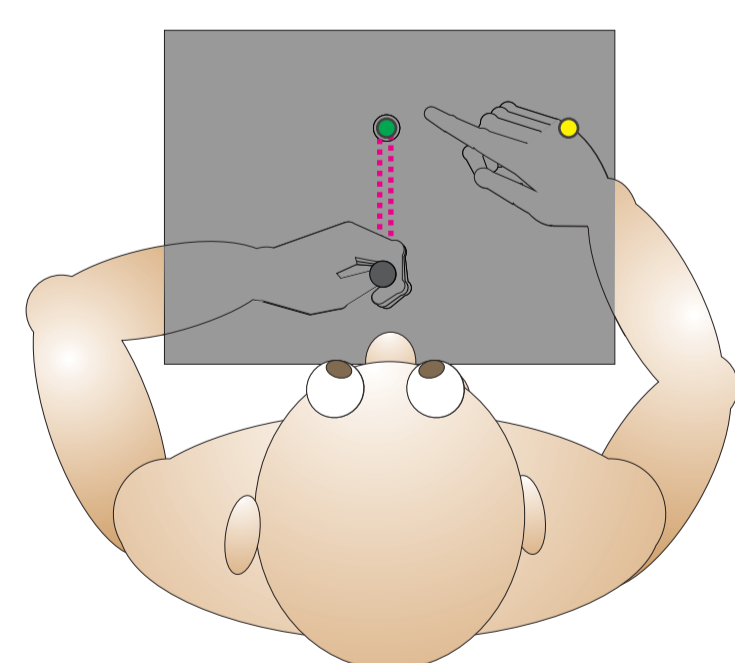
Reaching to VP targets



Inaccurate Endpoint Visual Feedback on V and P Reaches

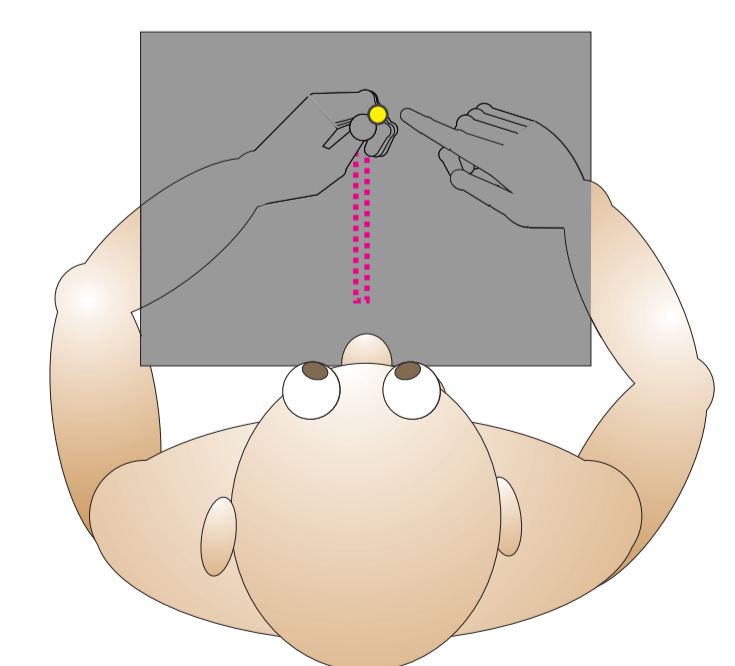
V target Reaches

Time 1. Accurate Feedback (FB)
Time 2. Lateral Error = 3x Actual Lateral Error
Time 3. Lateral Error = 1/3x Actual Lateral Error



P target Reaches

Time 1. Accurate Feedback (FB)
Time 2. Lateral Error = 1/3x Actual Lateral Error
Time 3. Lateral Error = 3x Actual Lateral Error



Trial Sequence: after exposed to FB in training

V (12) & P (12) Reaches	Randomized V (33) & P (33) & VP (45) Reaches
1	24
	135
Trial Number	

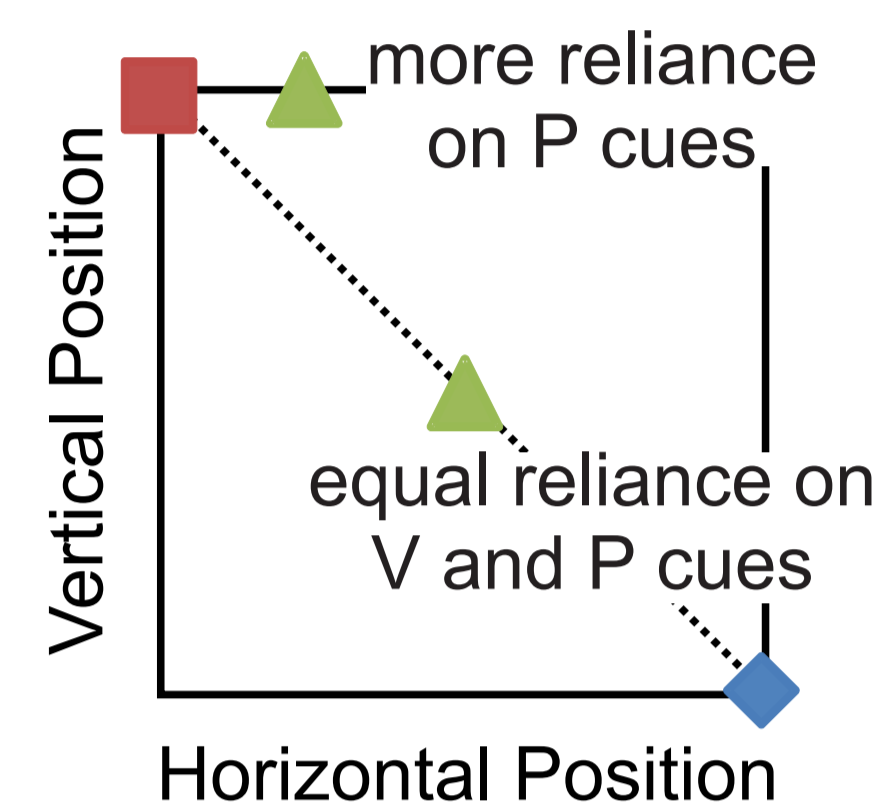
ANALYSES

Assumption: during VP reaches, if subjects "assign" more weight to proprioceptive cues, they will reach closer to their mean P endpoint position.

$$W_v = \frac{(P\text{-to-VP distance})}{(P\text{-to-VP distance}) + (V\text{-to-VP distance})}$$

$$W_p = 1 - W_v$$

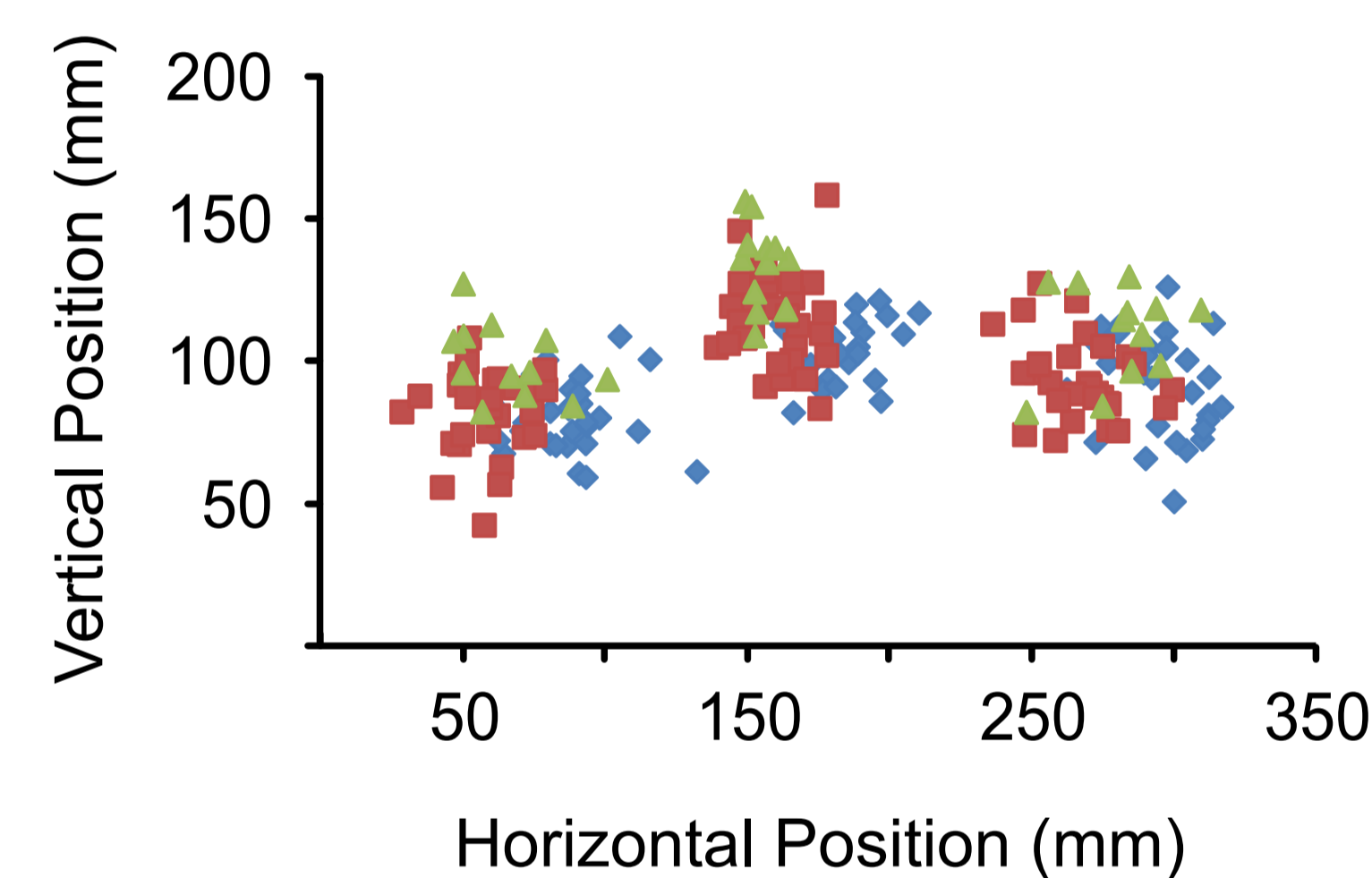
- ◆ V reach endpoint
- P reach endpoint
- ▲ VP reach endpoints



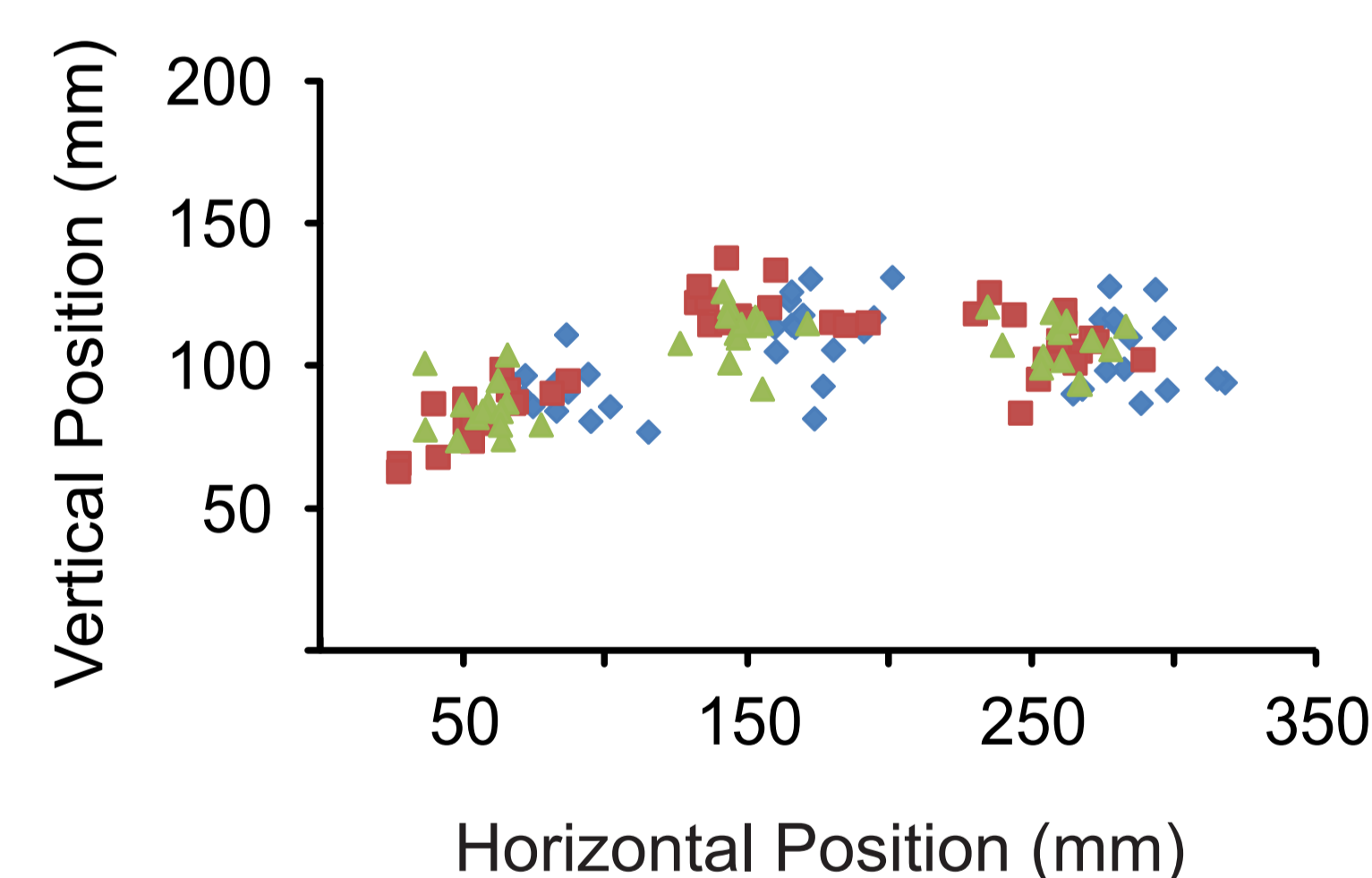
RESULTS

Reach Endpoint Position

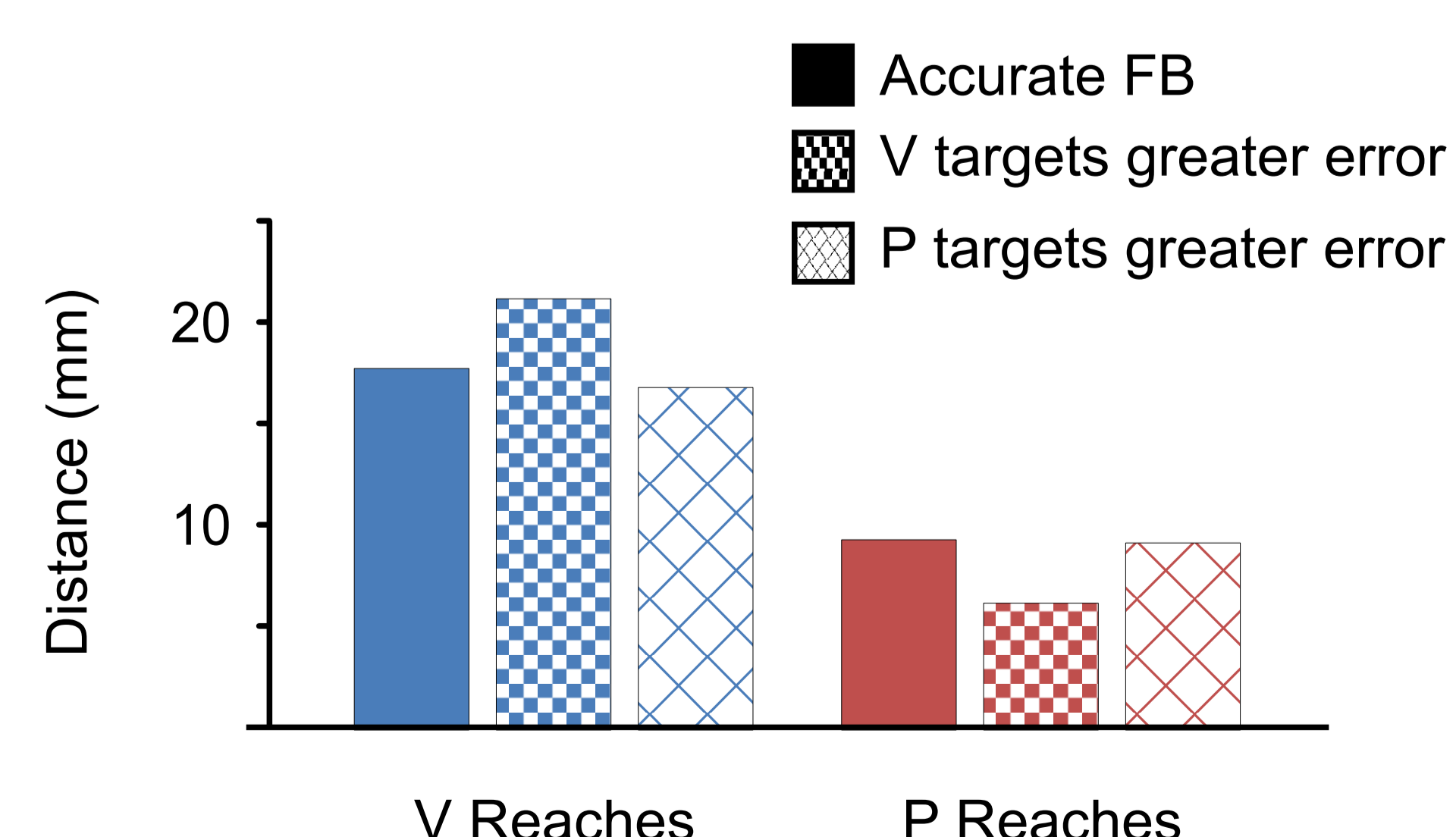
Initial Endpoints (Accurate Feedback)



Final Endpoints (after reaching with greater V errors)



Resultant Distance relative to VP reaches

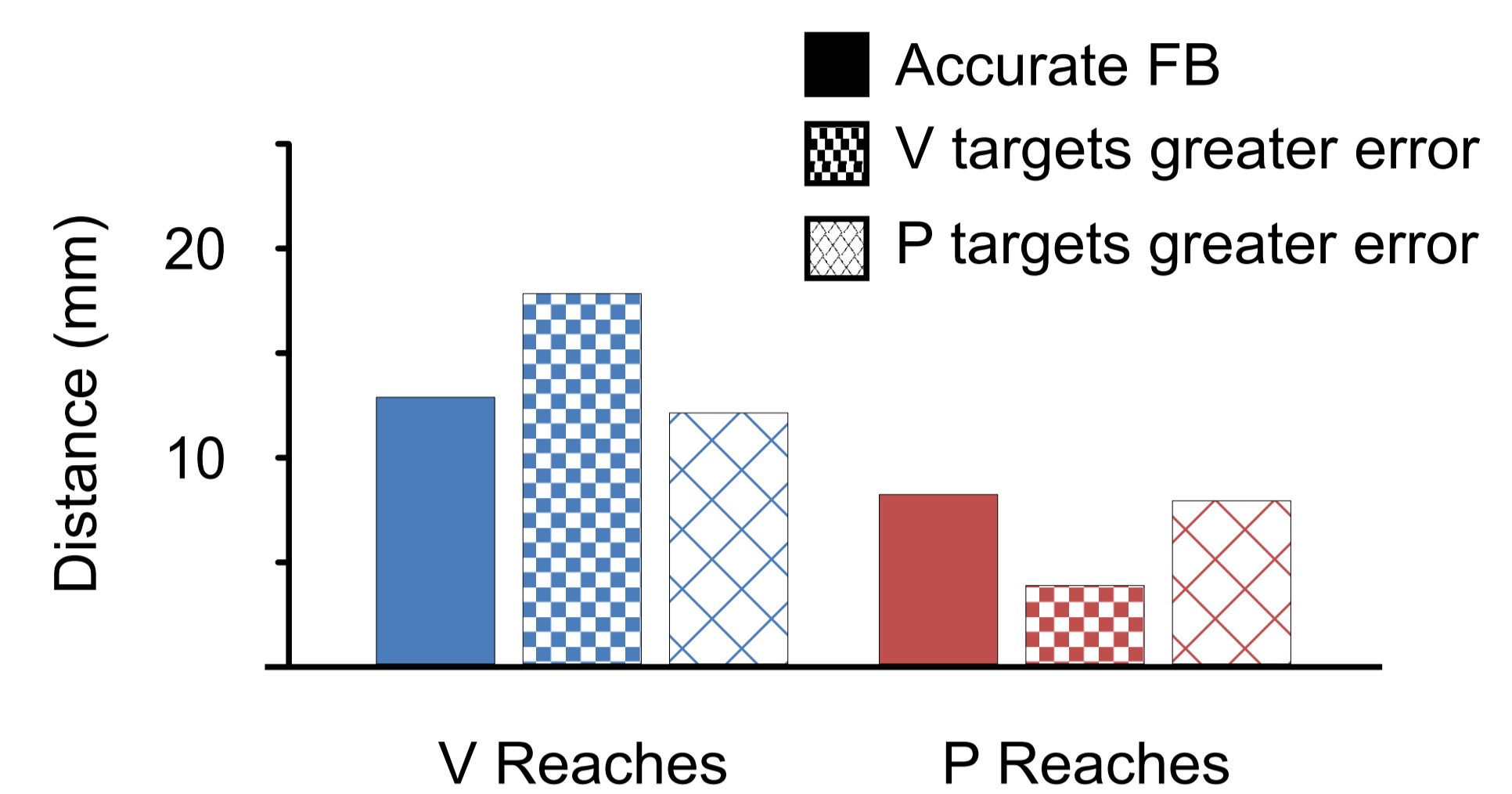


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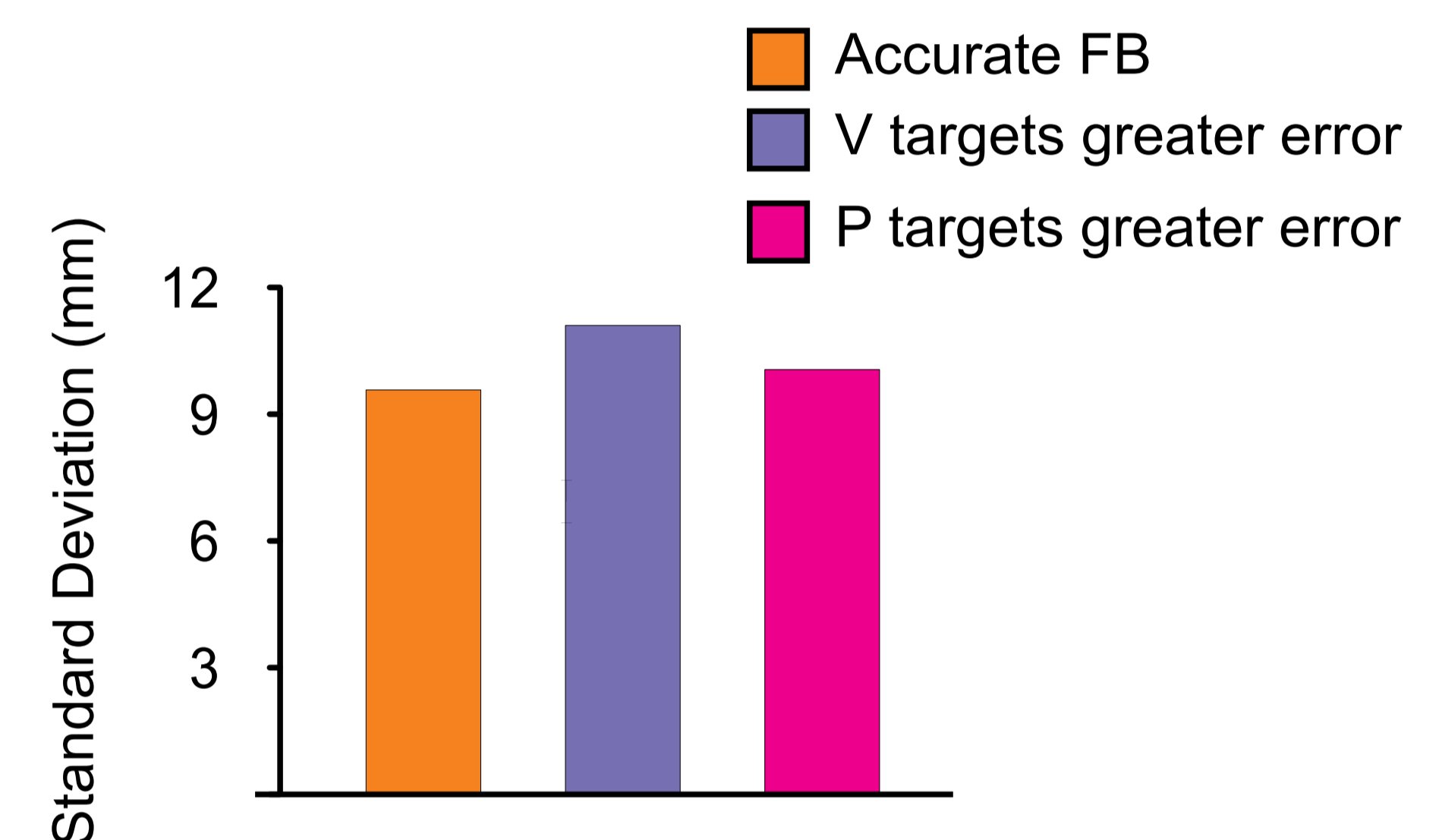
RESULTS

Reach Endpoint Position

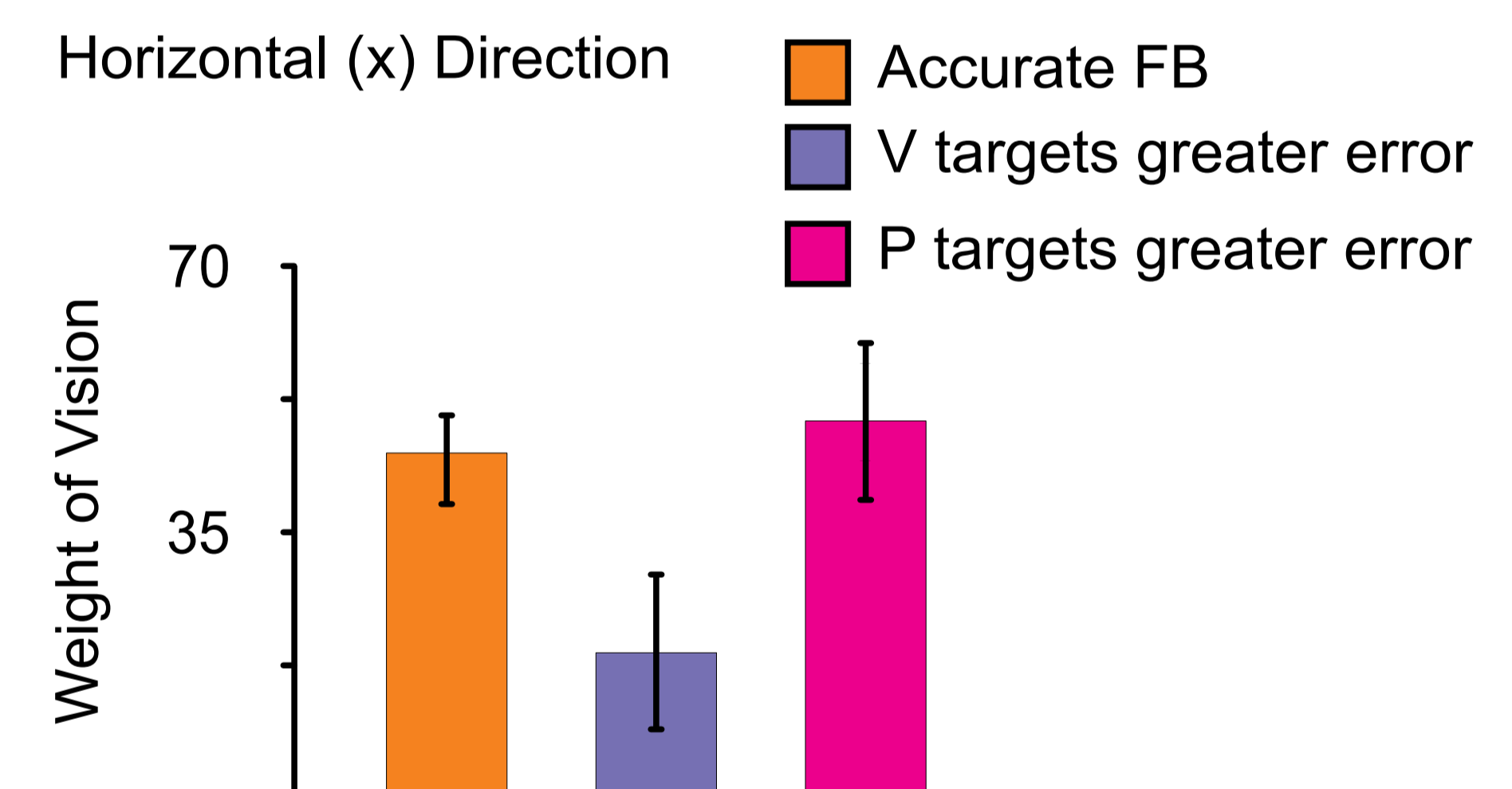
Horizontal (x) Distance relative to VP reaches



Precision in the Horizontal (x) Direction in VP reaches



% Weight assigned to visual cues in VP reaches



CONCLUSION

Results indicate that after experiencing misaligned endpoint error feedback, subjects adjusted their reaches to VP targets. In particular, after seeing endpoint error feedback that indicated their reaches to V targets were more (3x) inaccurate, and P targets were more (3x) accurate in the horizontal direction, participants adjusted their reaches to VP targets such that their endpoints were closer to their actual P reach endpoints. These results suggest that the brain can change how it weights sensory information regarding target location, relying on the sensory modality which has been experienced as most accurate. Surprisingly, subjects did not adapt their reaches to VP targets after seeing error feedback that indicated their reaches to V targets were more accurate, and P targets were more inaccurate. Future experiments will examine if similar weighting strategies are adapted when errors are manipulated in the vertical dimension (which is associated with greater precision of proprioception compared to vision).