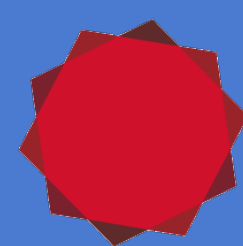


Relationship between the observer metamerism of color vision diversity and the spectral bandwidth of primary color spectrum

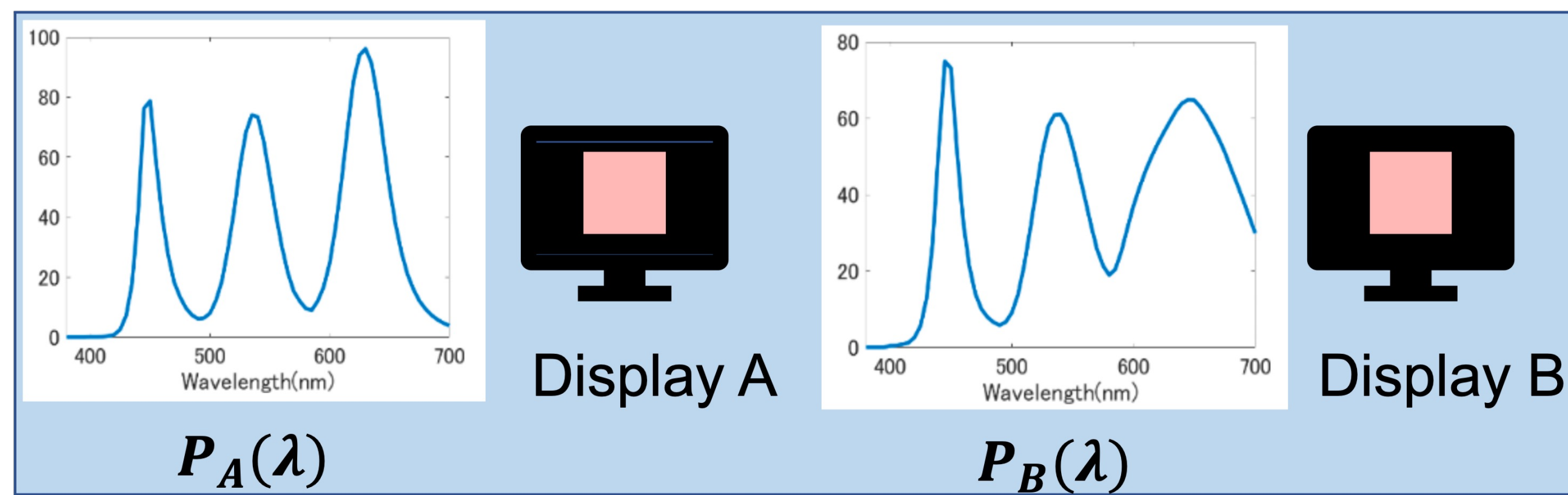


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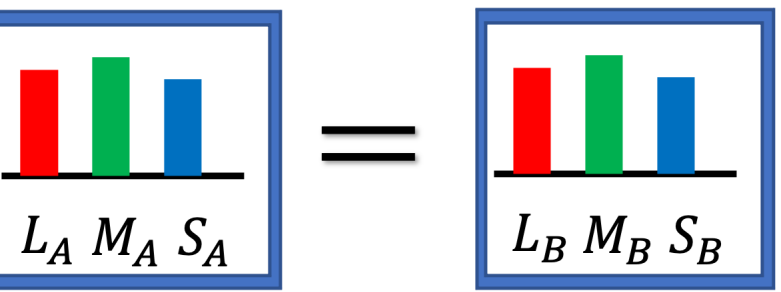
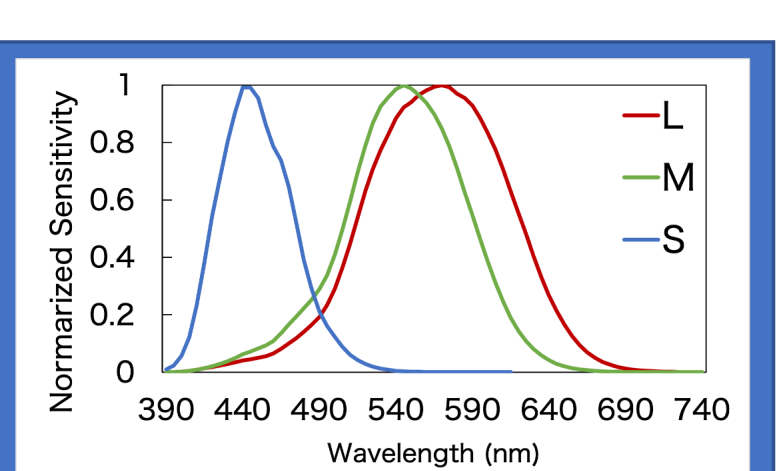
Background

Observer metamerism



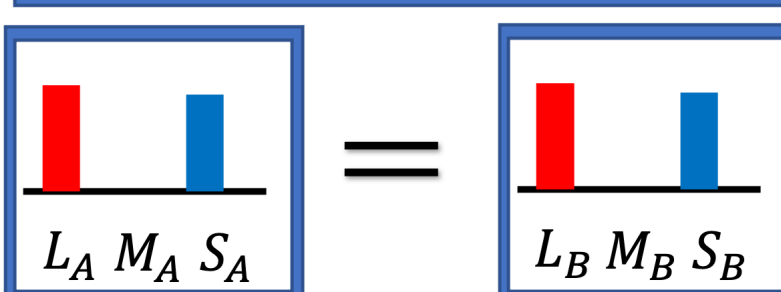
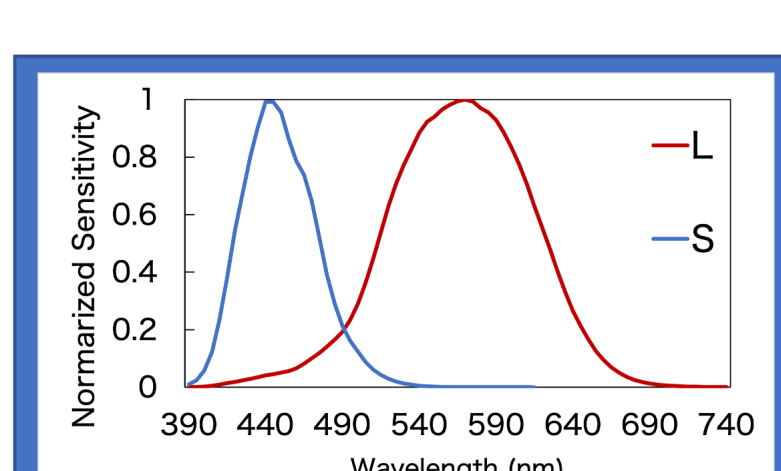
Multiply by LMS function

Normal color vision



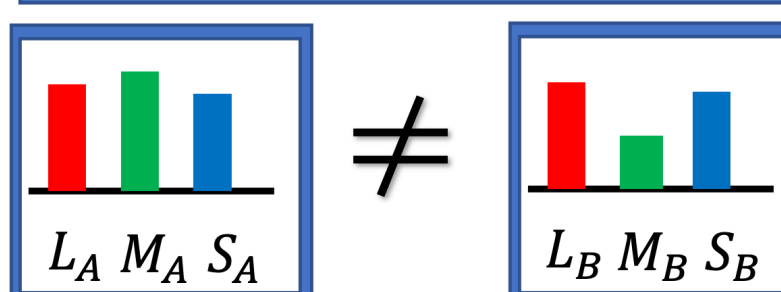
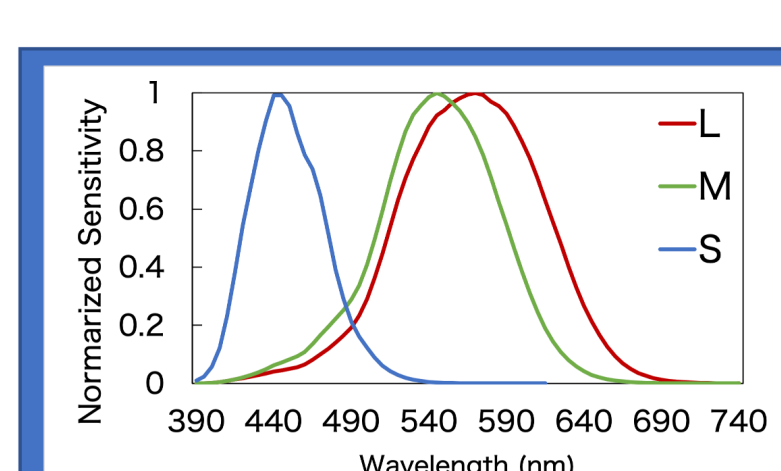
Values match

Deutan



Values match

Deuteranomalous



Values mismatch

Previous research

Observer metamerism occurs between color charts and wide gamut display.¹⁾

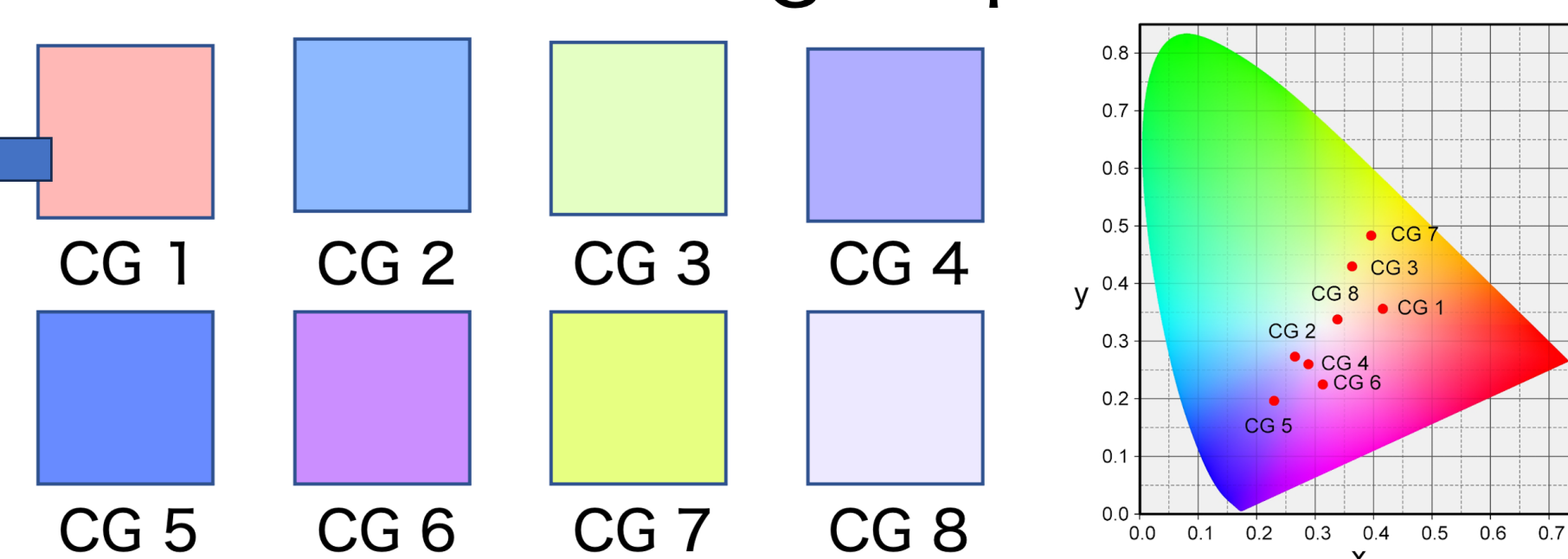
Direct relationship between spectral bandwidth and metamerism hasn't been rigorously examined.

Purpose

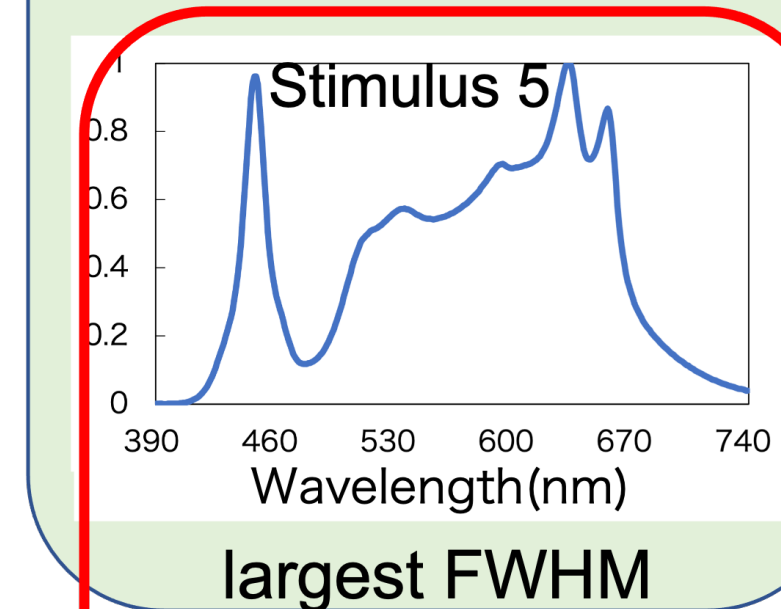
Verify the color discriminability of continuously modulating the spectral bandwidth of the metamers.

Stimuli

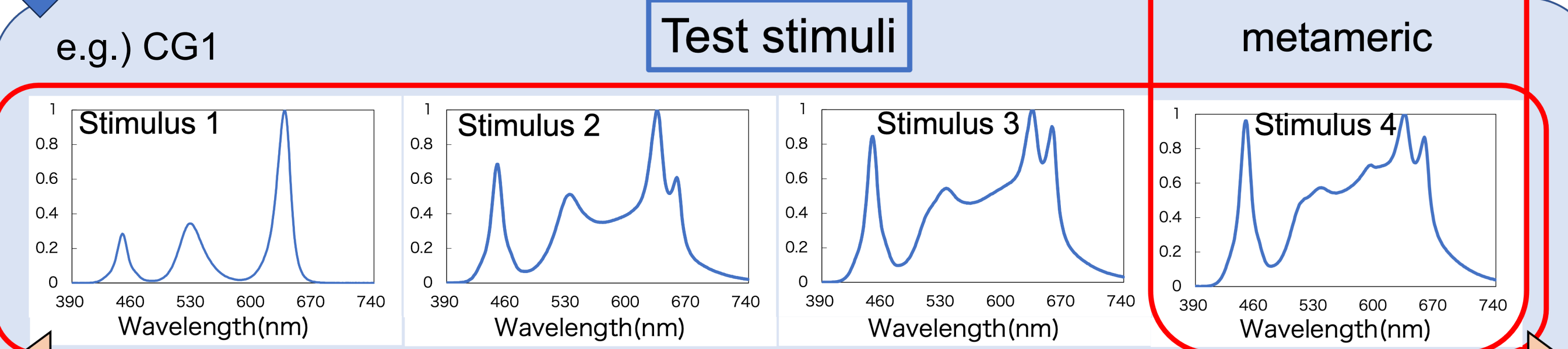
Color groups



Reference Stimulus

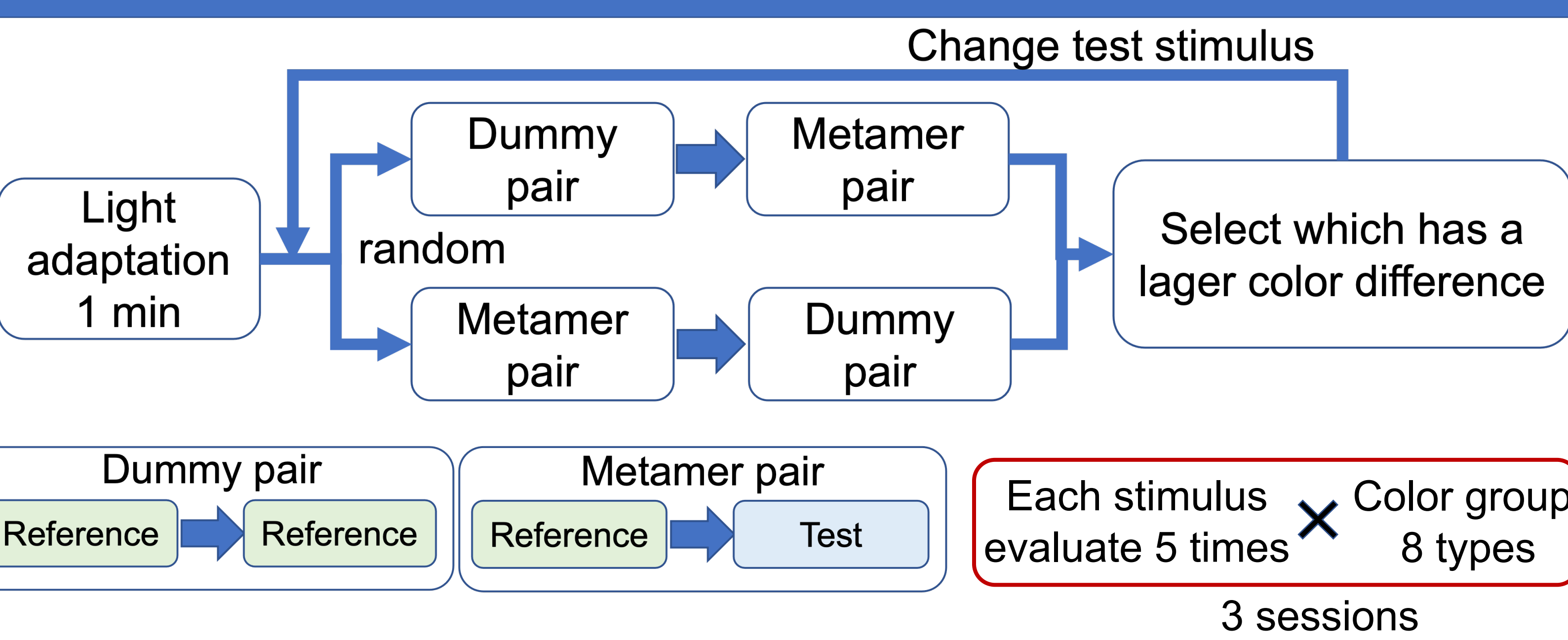


largest FWHM



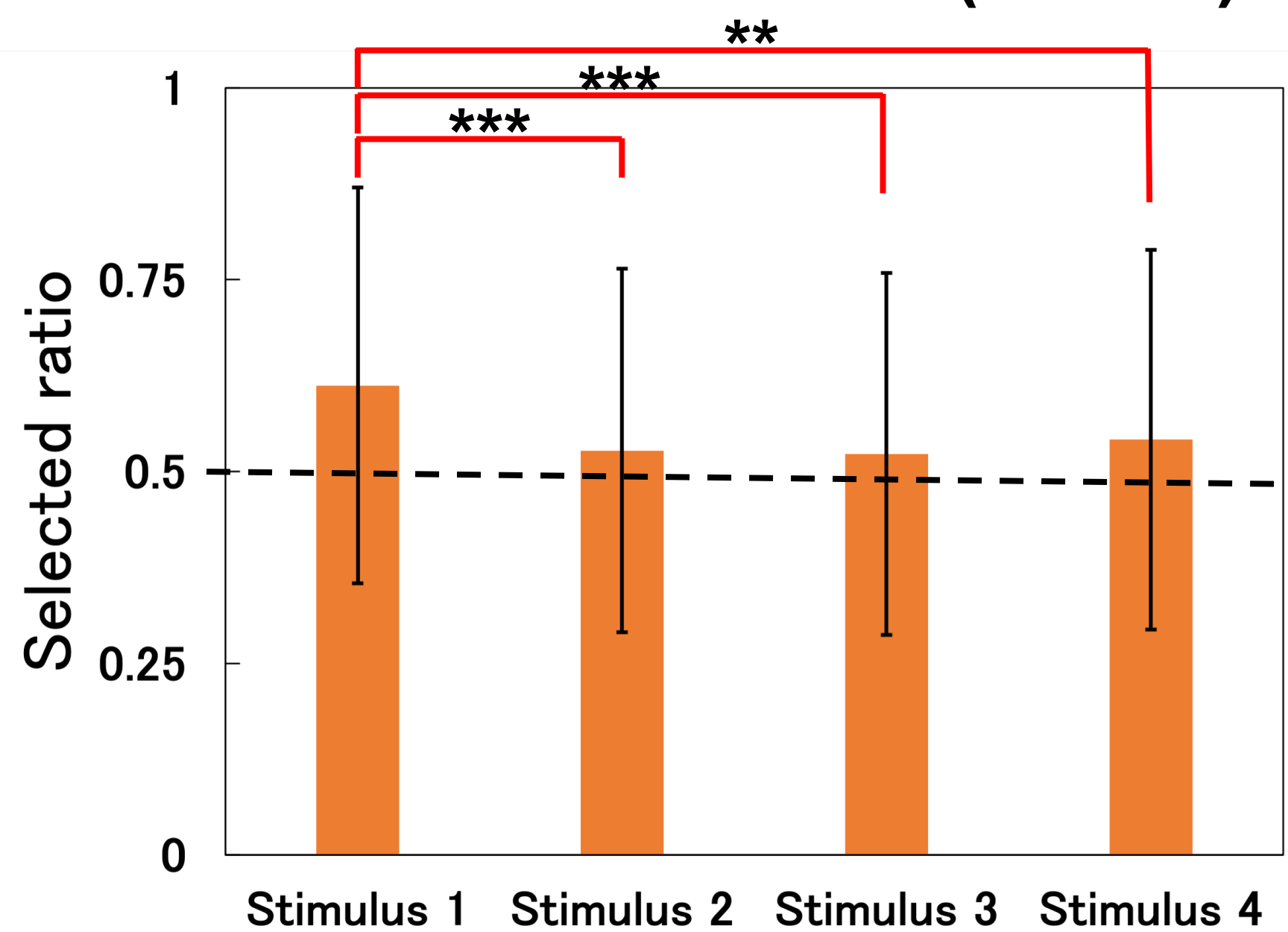
Bandwidth: narrow to broad

Procedure



Result

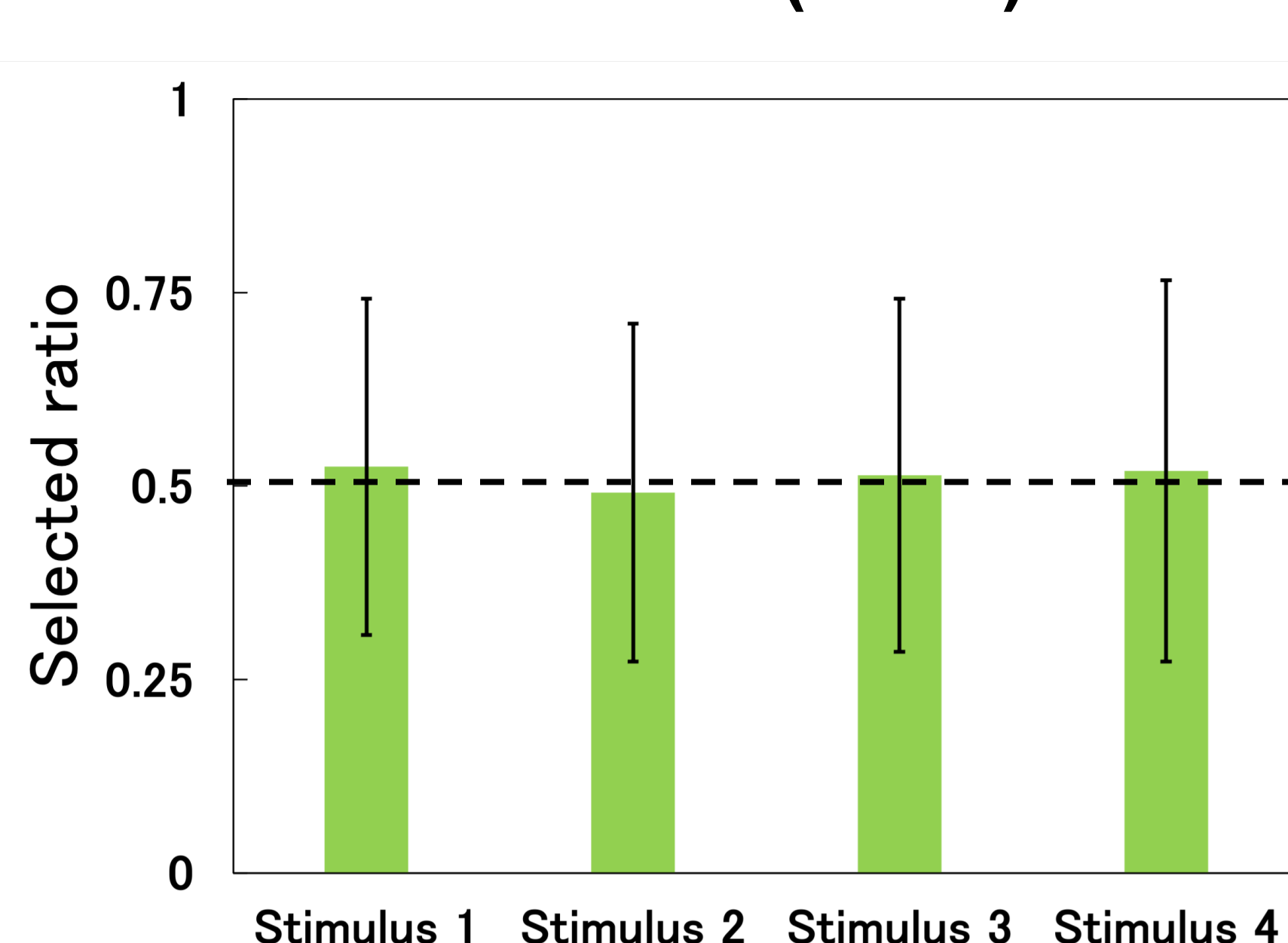
Normal color vision (N = 12)



Significant difference between Stimulus 1 and other stimuli

Metamerism occurred in narrow-band stimuli

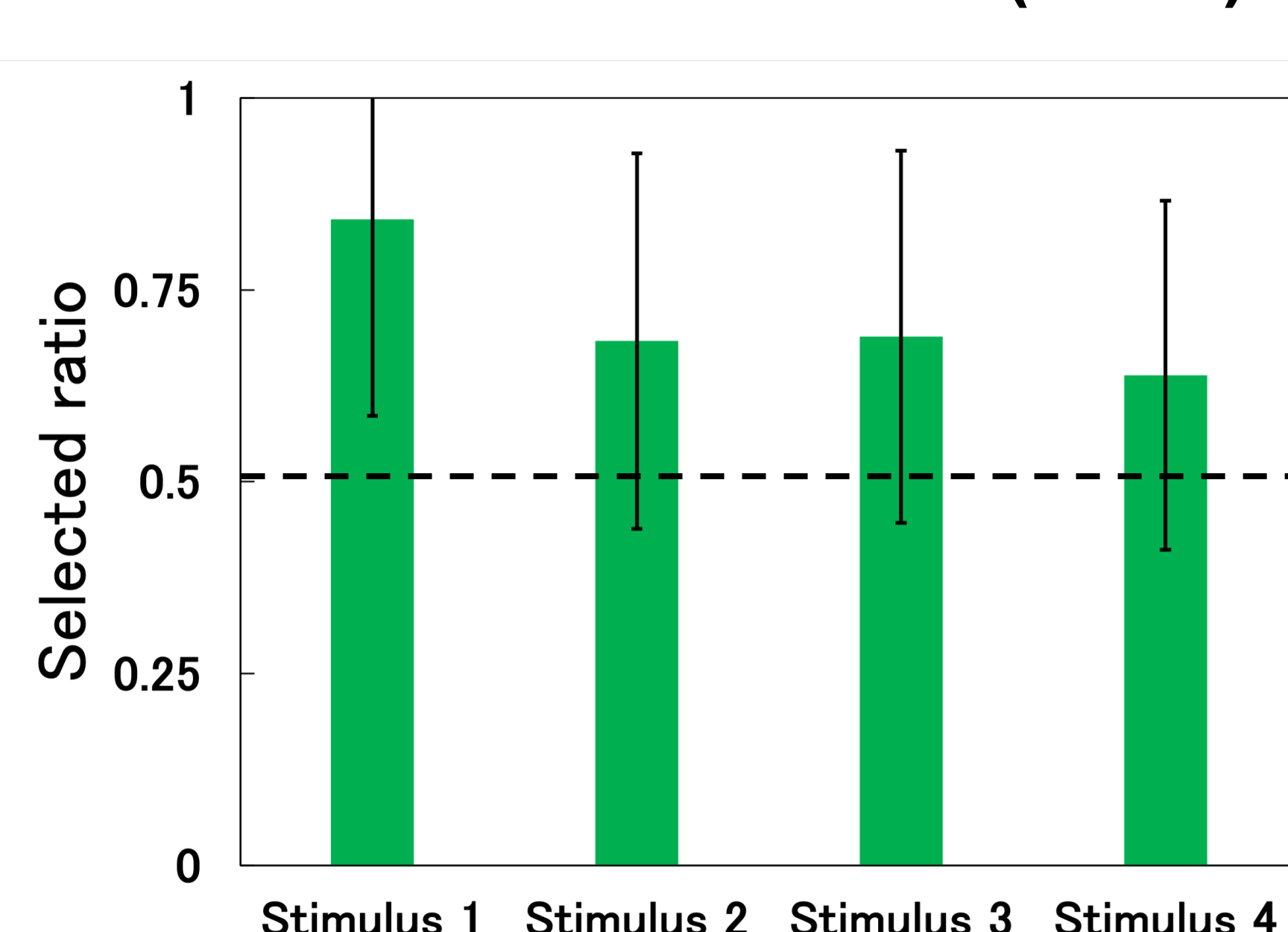
Deutan (N = 3)



All stimuli are near chance level

Metamerism did not occur

Deuteranomalous (N = 3)



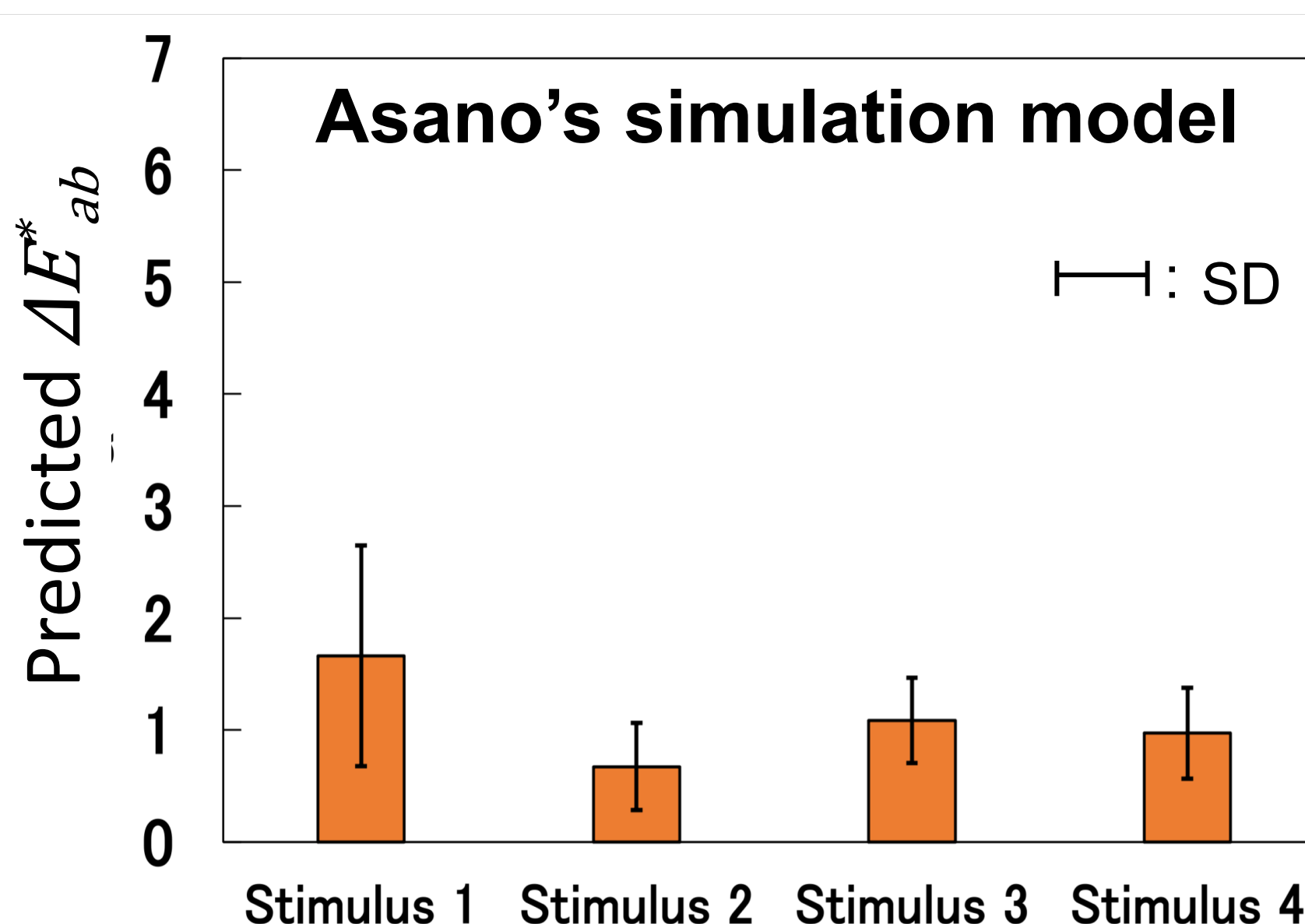
Stimulus 1, 2 and 3 exceed the chance level

Metamerism occurred with broader bandwidth than normal color vision

** : $p < 0.01$
 *** : $p < 0.005$
 — : SD

← chance level

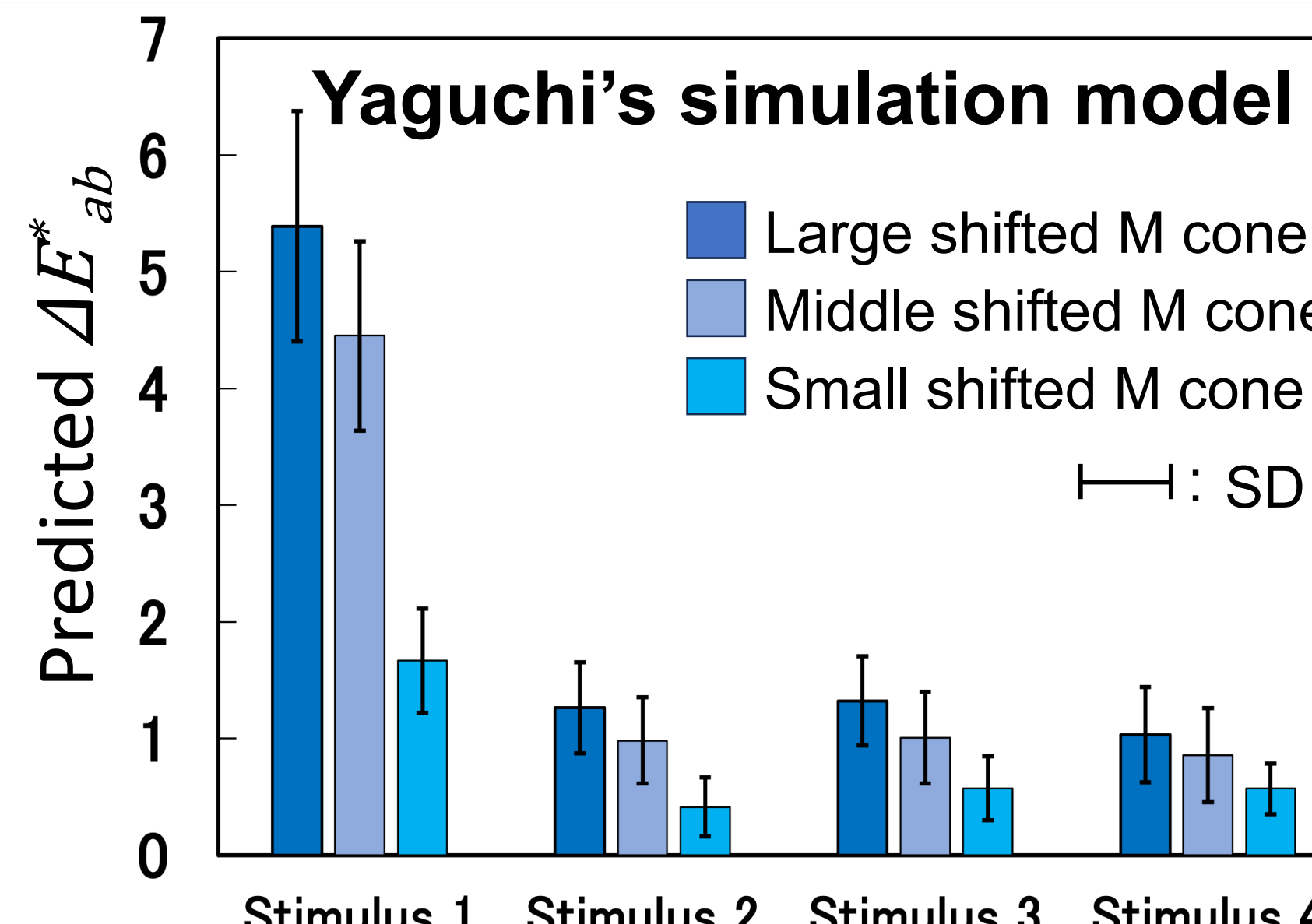
Discussion



Normal color vision

Experimental result : Metamerism in Stimulus 1
 Asano's model prediction²⁾ : ΔE^*_{ab} : large in Stimulus 1

Consistent with previous study⁴⁾ - Effect of individual differences



Deuteranomalous

Experimental result : Metamerism in Stimulus 1, 2 and 3
 Yaguchi's model prediction³⁾ : ΔE^*_{ab} : large in only Stimulus 1

Simulation models may underestimate metamerism due to bandwidth

Conclusion

The narrower the bandwidth, the more observer metamerism is to occur, and the effect is large in anomalous trichromat. Narrowing the bandwidth of light-emitting elements would be inappropriate from the perspective of color vision diversity.

1) Sunaga, S., Katsura, S., & Yaguchi, H. (2018). Color appearance of abnormal trichromatic vision in wide gamut displays. Journal of the Color Science Society of Japan, 42(3), 224-227. (in Japanese)

2) Asano, Y., Fairchild, M. D., & Blondé, L. (2016). Individual colorimetric observer model. PloS one, 11(2), e0145671.

3) Yaguchi, H., Luo, J., Kato, M., & Mizokami, Y. (2018). Computerized simulation of color appearance for anomalous trichromats using the multispectral image. Journal of the Optical Society of America A, 35, B278 – B286.

4) Ramanath, R. (2009). Minimizing Observer Metamerism in Display Systems. Color Research & Application, 34(5), 391-398.