Impact of myopia on visual attention and the potential link with cultural differences in visual perception

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Context

Easterners and Westerners have been shown to differ in many visual perceptual tasks, and evidence supports a broader allocation of attention among Easterners than Westerners. For instance, Easterners have a larger global advantage than Westerners in a Navon Task[1]; they fixate less the eyes and mouth, and more the center of the face during its processing[2]; they also tend to process faces in lower spatial frequencies[3]. Although it has been proposed that perceptual differences emerge from the cultural values (individualistic vs. collectivistic) assumed by each culture[4], a recent study didn't succeed at finding links between those cultural values and the eye fixation pattern during face processing[5]. In this study we explored another lower-level hypothesis that could explain the perceptual differences observed between Easterners and Westerners: the impact of myopia on visual attention. Recent evidence suggests that myopes are less affected by crowding in peripheral vision[6]. Since myopia prevalence is higher among Chinese compared to Caucasians individuals[7], this could potentially explain the visual perception differences observed between Easterners and Westerners. Two visual perception tasks having previously revealed cultural differences were used to compare the visual strategies of myopes and emmetropes.

Experiment 1

The ability to detect global and local target letters was measured with myopes (N = 14) and emmetropes (N = 22) using a Navon task (Figure 1). Target letters: E and H.

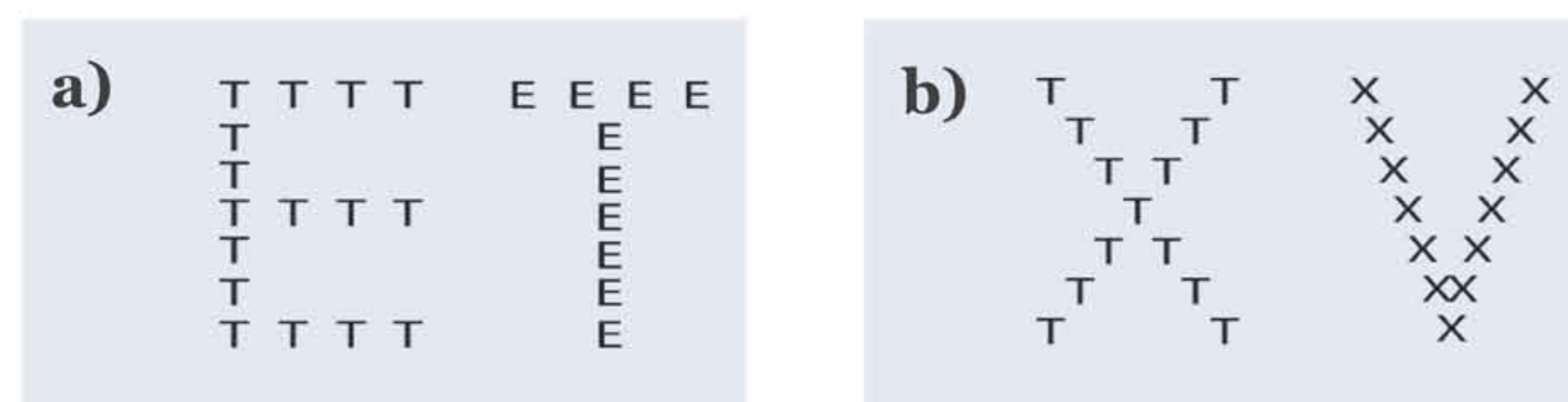- Cultural difference previously observed: higher global advantage for Easterners than for Westerners[1].

Figure 1 – Examples of stimuli in the Navon task a) Stimuli with the target letter E at a global or local level. b) Stimuli with no target letter.

References

(1) McKone, E., et al. (2010). *Vision research*, 50(16), 1540-1549; (2) Blais et al. (2008). *PLoS one*, 3(8), e3022; (3) Tardif, J. et al., (2017). *Journal of Experimental Psychology: Human Perception and Performance*, 43(2), 294-306; (4) Nisbett et al. (2001). *Psychological Review*, 108(2), 291-310; (5) Ramon, M. et al., (2016). Journal of Vision, 16(12), 1396-1396; (6) Carroll, S., Maiello, G., Harrison, W., & Bex, P. (2016). *Journal of vision (accepted abstract)*; (7) Lam, S-Y., Lam, C-H., Cheng, C-K., & Chan, Y-L. (2012). *Ophtalmic and physiological optics*, 32, 17-24; (8)Willenbockel, V., et al. (2010). *Journal of Experimental Psychology: Human Perception and Performance*, 36(1), 122-135; (9)Chauvin, A., Worsley, K. J., Schyns, P. G., Arguin, M., & Gosselin, F. (2005). *Journal of vision*, 5(9), 1-1; (10) McKone, E., Davies, A., & Fernando, D. (2008). *Perception*, 37, 1765-1768.

Results

For each participant, the global or local bias was calculated by subtracting the average reaction time (RT) to correctly detect local target letters from that to correctly detect global target letters. The same calculation was performed with average accuracy. The RT results indicated no difference in the global or local bias between myopes and emmetropes [$t(31)$=1.51, p=0.14]. However, a difference was found with accuracy, indicating a higher global bias for emmetropes than myopes [$t(31)$=-2.68, p=0.01].

Table 1 – Average global or local bias for myopes and emmetropes in terms of reaction times and accuracy. Standard deviations in parenthesis.

	Myopes	Emmetropes
RT (sec)	0.0056 (0.0759)	-0.0315 (0.0645)
Accuracy (%)	-4.74 (6.83)	1.92 (7.08)

Experiment 2

The spatial frequency (FS) utilization of 12 participants (6 emmetropes, 6 myopes) was measured using the SF bubbles method[8] (Figure 2) in a face identification task.

- Cultural difference previously observed : Higher utilization of low SFs by Easterners than by Westerners, and higher utilization of high SFs by Westerners than by Easterners.
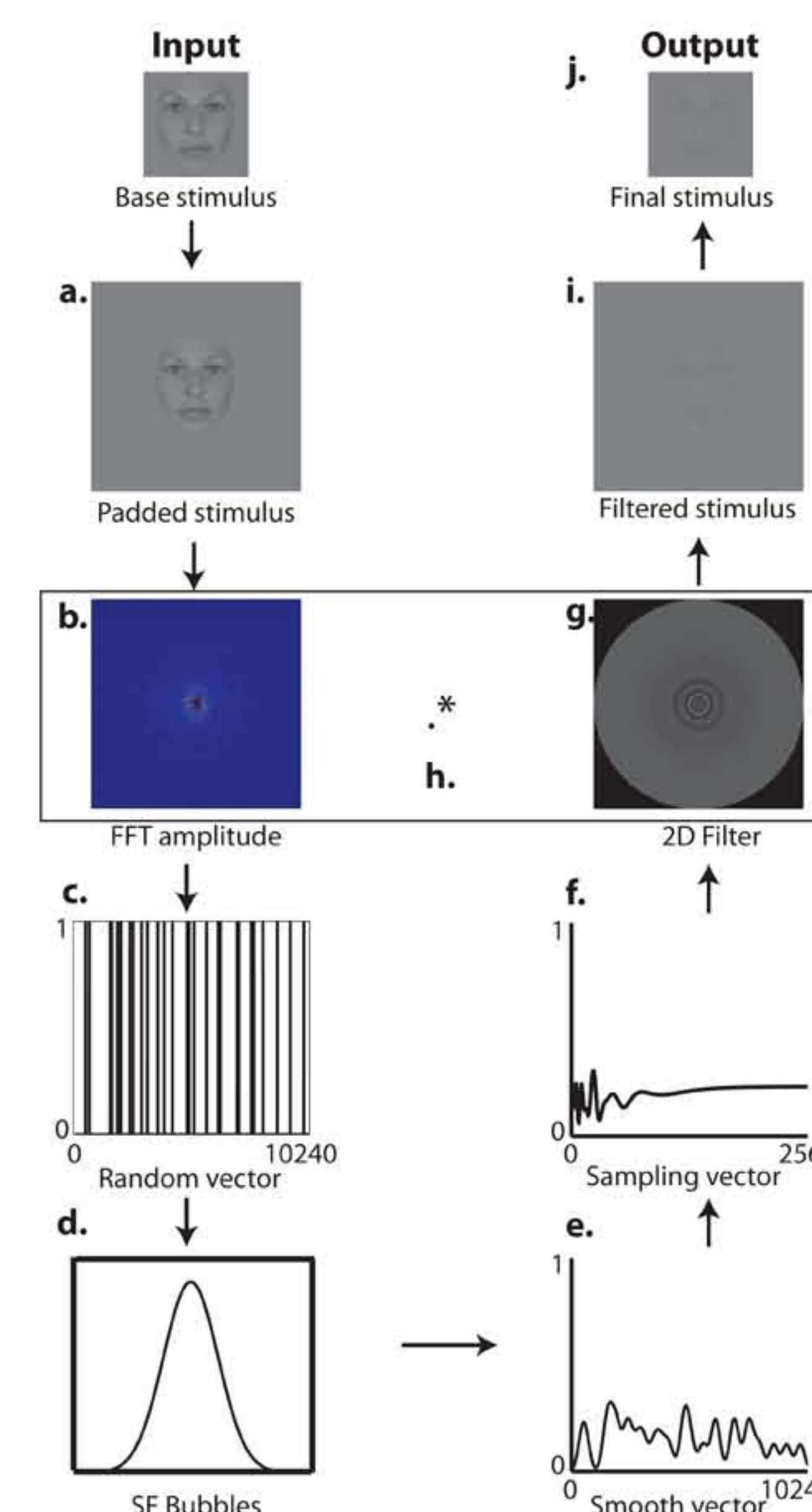

Figure 2 – Example of stimulus creation using the SF Bubbles method.

Results

The number of bubbles needed by myopes (M=17.7, SD=18.9) did not significantly differ from what was needed by emmetropes (M=26.4, SD=17.2), [$t(10)$ = 0.84, p=0.42], suggesting that the amount of information to reach the target accuracy (54%) was similar for both groups.

A weighted sum of the SF vectors used during the experiment was performed, using accuracies as weights. Statistical thresholds were obtained using the Pixel test from the Stat4CI[9]. Results indicate a higher utilization of middle-high SFs, between 14.7 and 19 cpf, by myopes than by emmetropes.
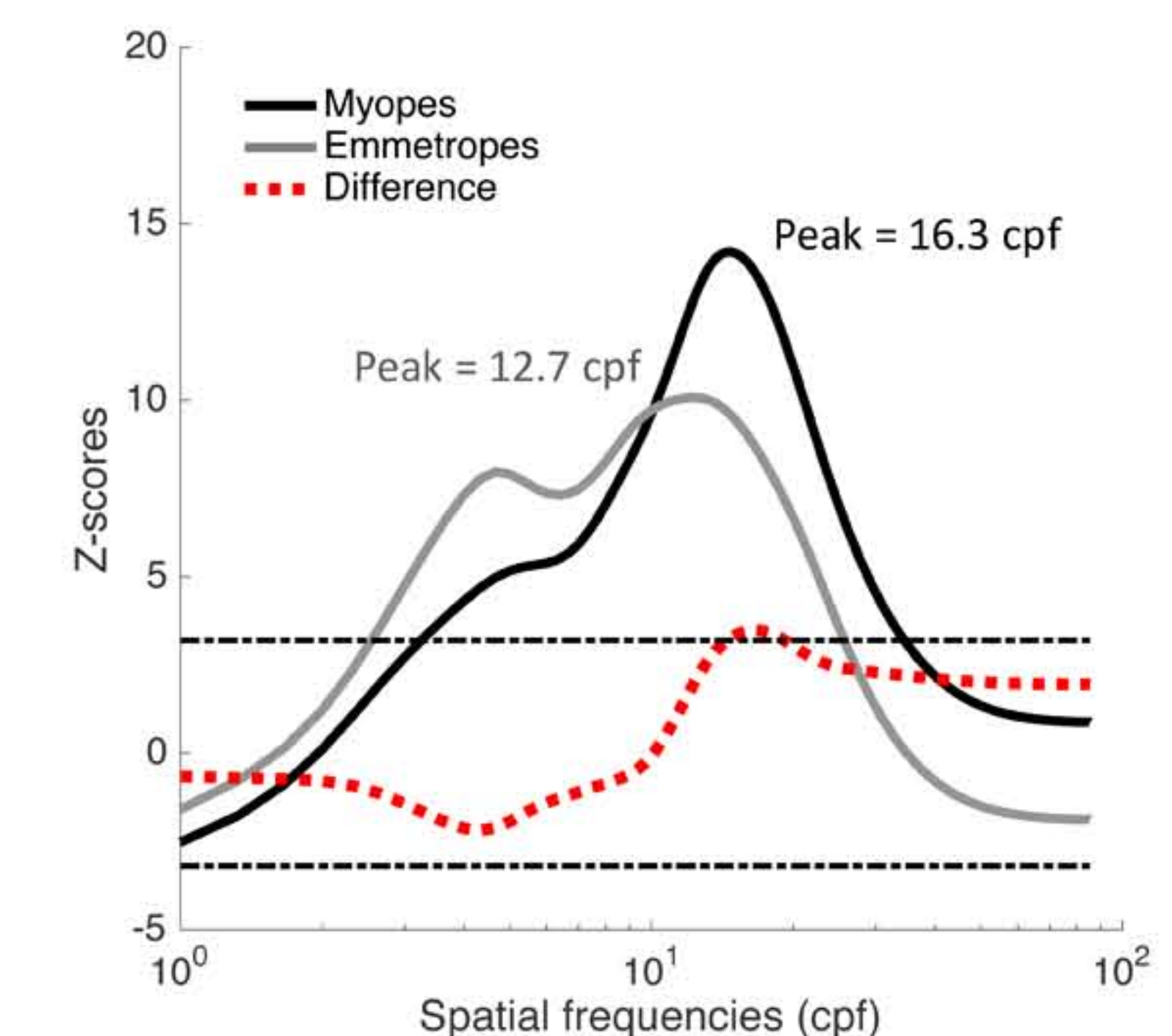

Figure 3 – Spatial frequency tuning of myopes and emmetropes during a face identification task. Statistical thresholds are represented by dotted black lines.

Discussion

- These results do not support the hypothesis that the difference in the prevalence of myopia in Asia and North America underlies the cultural differences observed in visual perception.

- Besides, McKone, Davis & Fernando (2008)[10] tested Asian-Australians on the Navon task and did not find any correlation between the degree of myopia and the strength of the global or local bias.

- Future studies will investigate the possible interaction between culture and the impact of myopia on visual perception.

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