The Impact of Culture on the Processing of Spatial Frequencies during the Recognition of Homogeneous Objects

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Context

Several studies have shown cultural differences in the fixation patterns observed during tasks of different natures, like face recognition[1,2]. The general pattern of findings suggests that East Asians rely more on peripheral processing and deploy their attention more broadly than Westerners[3]. In line with this idea, studies have shown that East Asians process faces in lower spatial frequencies (SF) than Westerners[4]. However, it is not clear if this cultural difference in SF processing is specific to faces. In fact, it has not been found during the processing of scenes and non-homogeneous objects[5]. Compared with scenes and most everyday objects, faces have homogeneous configurations. This study thus verified if a cultural difference in SF tunings occurs while processing homogeneous objects : Greebles[6] (see Figure 1).
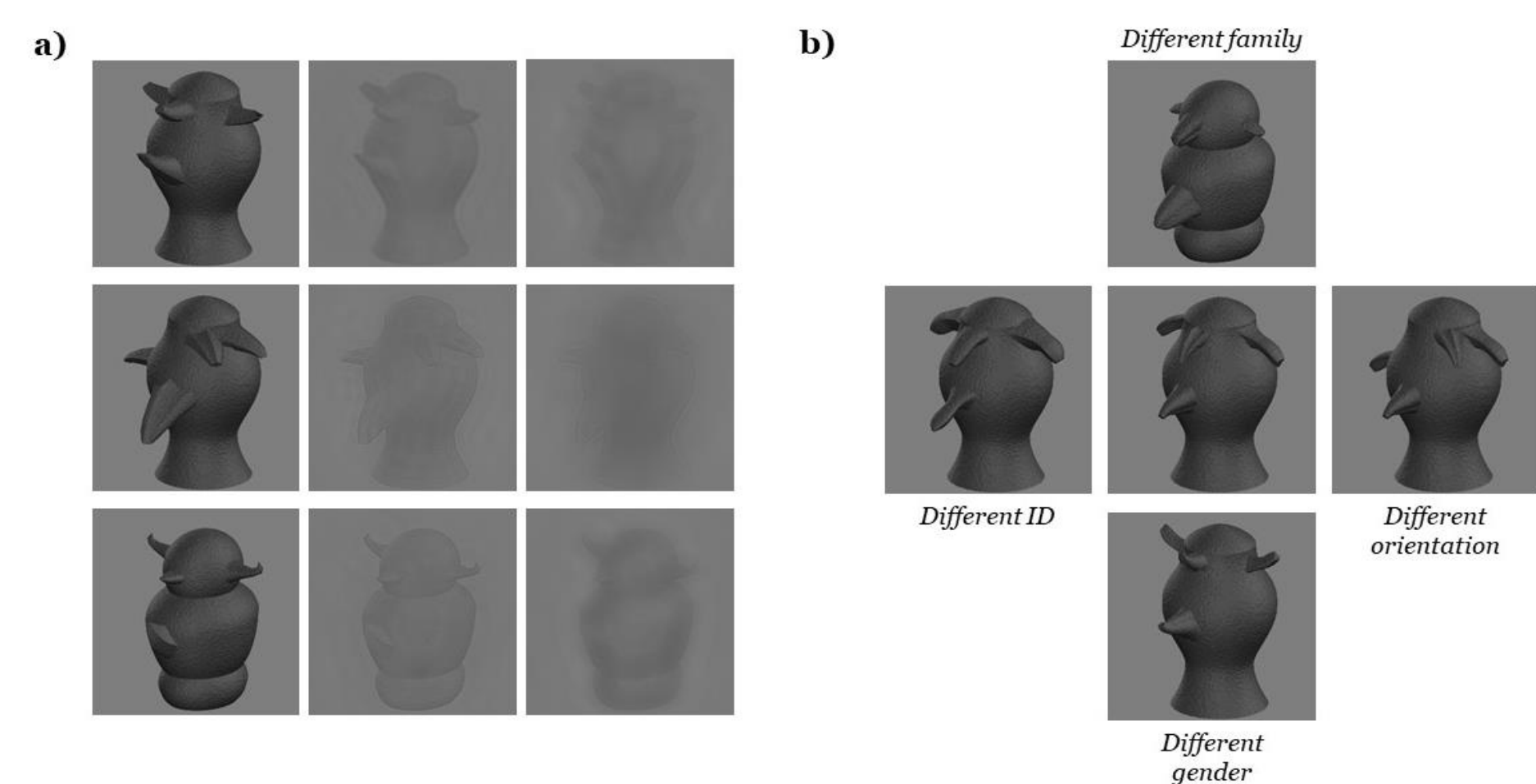

Figure 1. a) Example of stimuli. The first column shows different Greebles whereas the second and third ones shows different SF filters. b) Example of a stimulus where four different properties were changed.

Method

- 132 participants recruited on Prolific
- Online study consisting of 600 trials of a same-different task
- A credit card test was used to determine distance from the screen
- Participants went through a practice session where they needed to have at least 85% accuracy on broadband stimuli to continue
- Stimulus were filtered using the SF bubbles method[7]. The filter allows each trial to display certain SF, as explained in Figure 2.
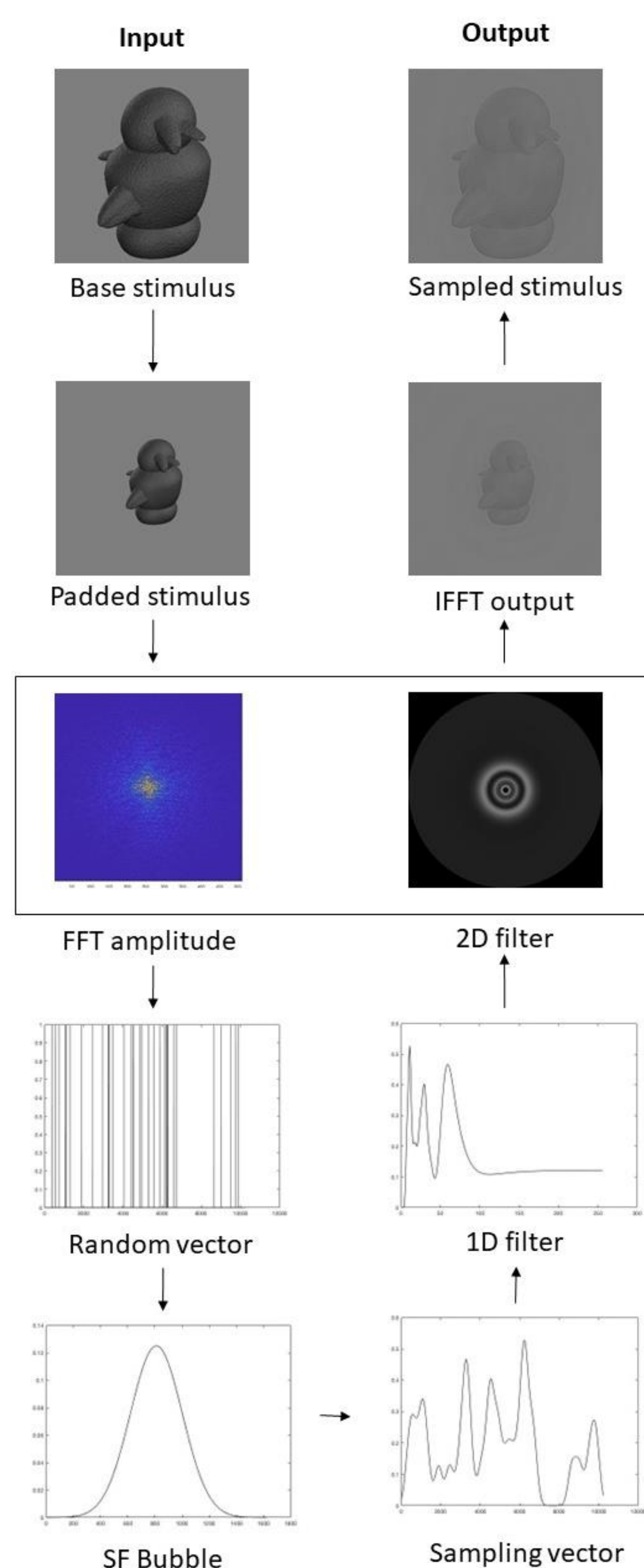

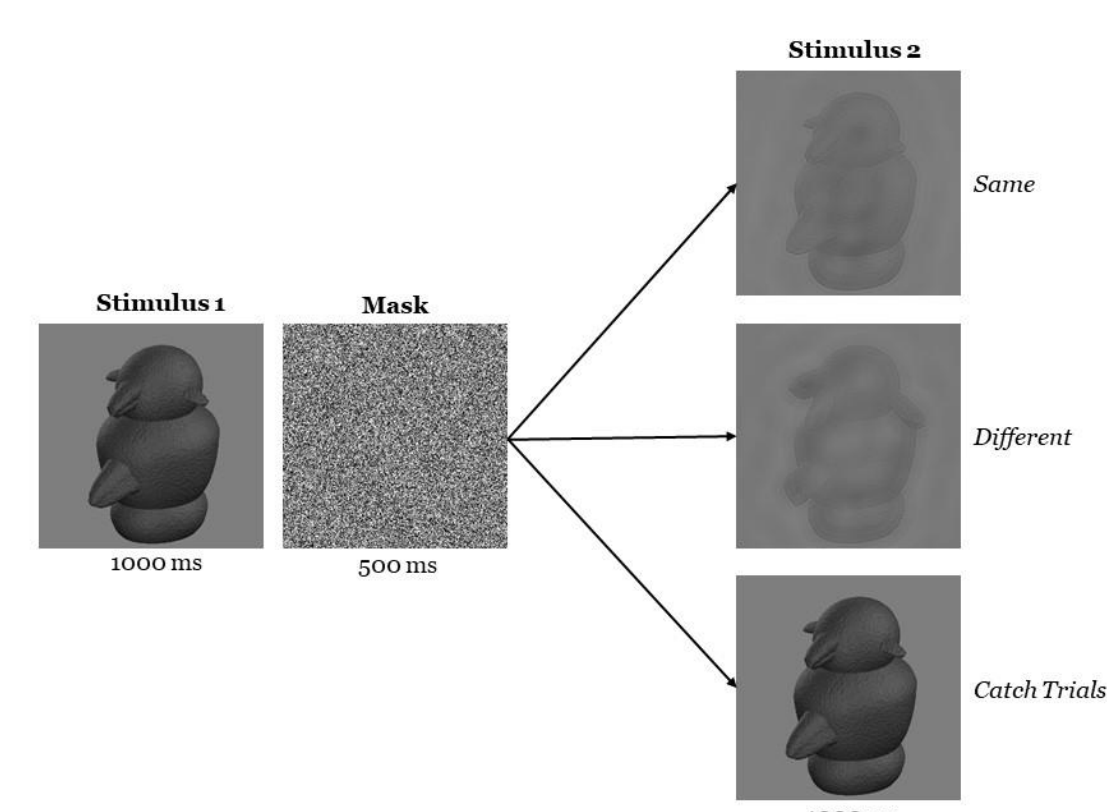*Figure 2.* Illustration of the SF bubble technique.

Figure 3. Examples of trials. The first row displays the same stimulus filtered. The second row displays a stimulus from a different ID. The third row displays a catch trial.

Results

Participants

One-sample T-tests (Pixel test from the Stat4CI[8]) indicate that SF ranging between 2.42 and 13.33 cycles/object (Tcrit=3.89, p<.05), and between 3.03 and 16.57 cycles/object (Tcrit=3.53, p<.05) were used by East Asians and Westerners, respectively (see Figure 4).
We conducted a 10,000 iteration bootstrap analysis, generating random samples of same size for both cultural groups. Results show that low SF ranging between 2.62 and 4.04 cycles/object were significantly more used by East Asians (p<.025).

Template matcher

A template matcher analysis was conducted to verify the most diagnostic SF from a purely computational point of view. The results indicate that low SF ranging from 0.61 to 2.22 cycles per object are the most diagnostic (see Figure 4).

	Westerners	East Asians	Template matcher
N Participants	93 (males =45)	39 (males=15)	
N Bubbles	M= 23.74, SD = 12.76	M=19.82, SD = 10.98	22
Accuracy	M= 79.07%, SD = 4.00%	M= 79.60%, SD= 3.70%	79.76%

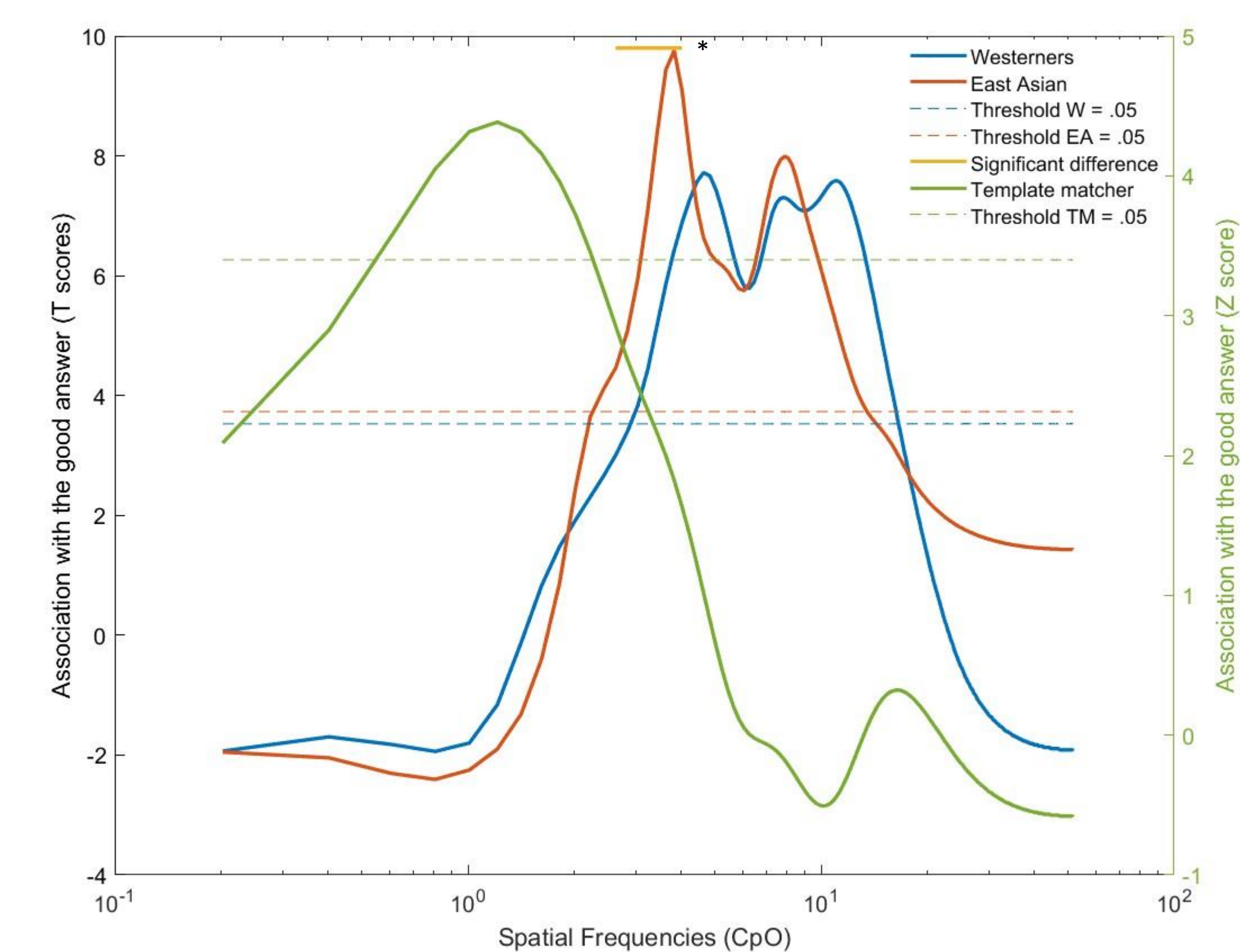*Table 1. Descriptive statistics.*

Figure 4. Spatial frequencies used by each culture and by the template matcher. Higher T scores or Z scores represent the spatial frequencies that were most diagnostic for the task.

Discussion

- As was found with faces in a previous study, our results indicate that East Asians process Greebles in lower SF than Westerners.
- Since such a difference was not found with complex objects and scenes, this may indicate that East Asians and Westerners differ in their visual processing, especially with homogeneous objects.
- The source of this difference remains poorly understood. Future studies will aim to better understand the factors that may lead to the emergence of cultural differences in the processing of homogeneous objects.

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