Link between fixation location and spatial frequency utilization in face recognition

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Context

Recent face perception studies have explored cultural and individual differences with regard to visual processing strategies. Two main strategies, associated with distinct eye movement patterns, have been highlighted: **global** (or holistic) face processing involves fixations near the center of the face to facilitate simultaneous peripheral processing of key facial features (i.e. eyes and mouth); **local** (or analytic) face processing involves fixations directed to those facial features[1, 2].

Interestingly, some studies have also found cultural and individual differences in the spatial frequencies (SFs) used for face identification, which seem to fit the eye movement data. For instance, East Asians use a more global fixation pattern[3], and lower SFs[4], compared to Western Caucasians; myopes tend to use a more local fixation pattern, and higher SFs, compared to emmetropes[5]. **However, whether a common underlying link between eye movements and SF use exists is still unknown.** Thus, the current study proposes to investigate this question.

Task 1

All participants' (N = 24) eye movements were monitored with Eyelink 1000 during an Old/New face recognition task (Figure 1).

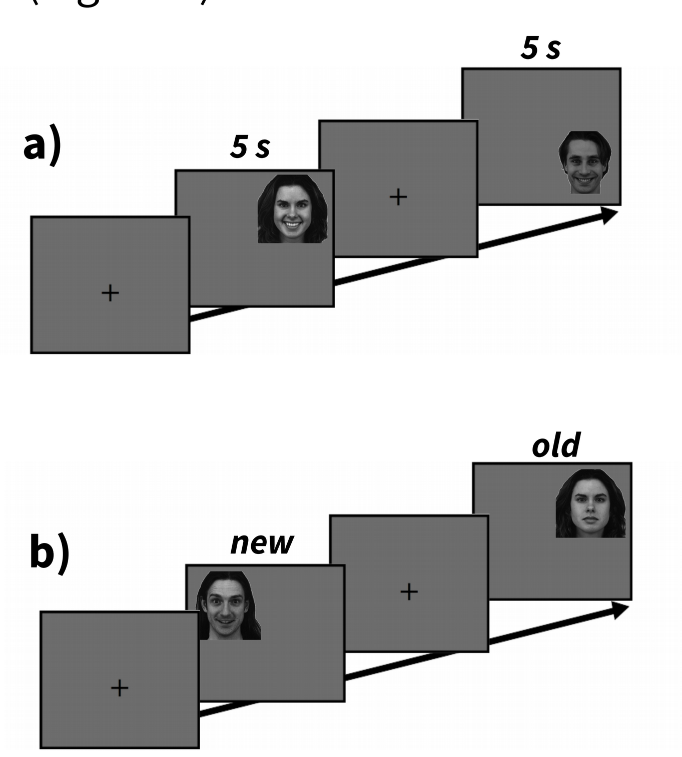

Figure 1 – Examples of stimuli in the Old/New task: a) Learning period (sequence of 14 faces, two blocks); b) Recognition period (sequence of 28 faces (14 new), two blocks).

Task 2

Participants' SF use was measured with the SF Bubbles method[6] (Figure 2) during a face identification task.

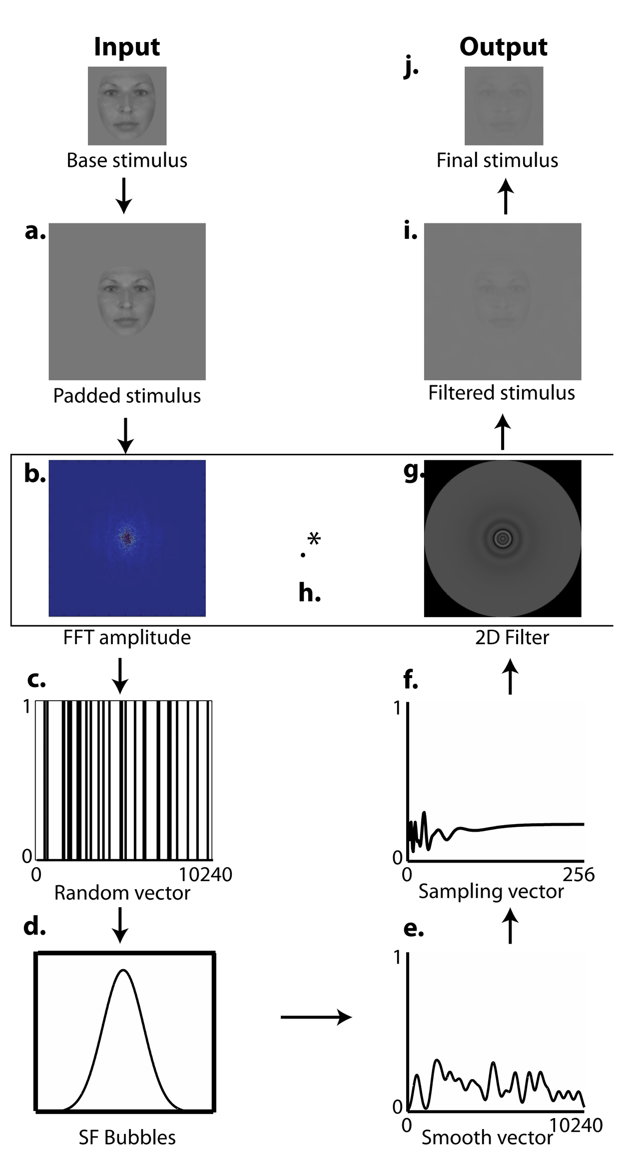

Figure 2 – Example of stimulus creation using the SF Bubbles method.

Results

1 – Fixation duration maps were computed for each participant using the *iMap4* toolbox[7]. Only accurate recognition trials were included.
2 – Average euclidian distances between all eye movement samples and the center point of the face were calculated for each participant.
3 – A frequency distribution (histogram) of the average euclidian distances across participants was plotted (Figure 3).
4 – The distribution mean was used to create two groups: "fixations closer to center" (group 1) and "fixations further from center" (group 2). Fixation biases for both groups are shown on Figure 4.
5 – A weighted sum of the SF vectors used during the experiment with the SF Bubbles method was performed, with accuracies as weights. Statistical thresholds were obtained using the Pixel test from the *Stat4CI toolbox*[8]. Group differences in SF use are shown on Figure 5.
6 – Participants individual SF tuning peaks were calculated, and a linear correlation was performed with those participants average euclidian distances (Figure 6).
7 – Finally, steps 2 to 6 were reproduced using only initial fixations.

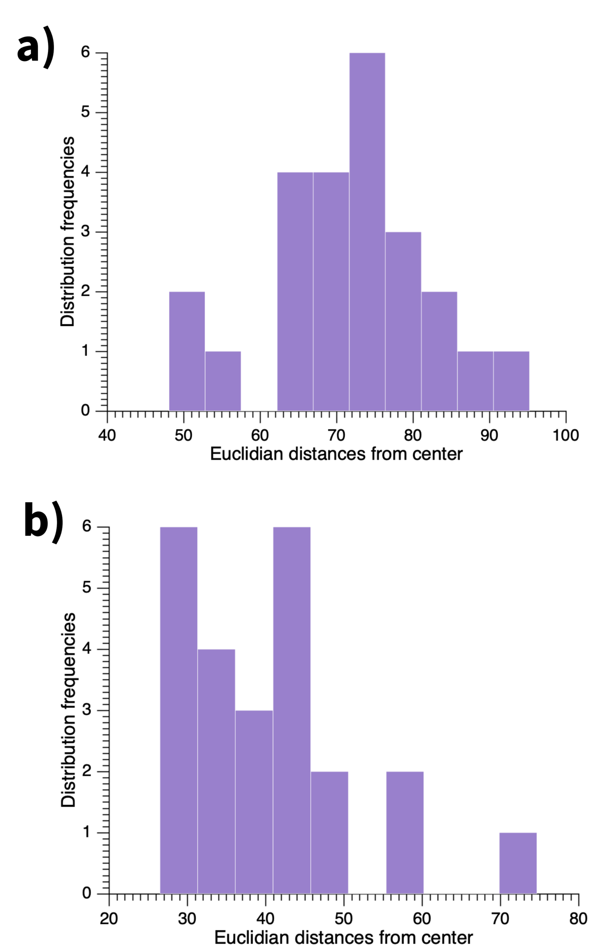

Figure 3 – Histograms of average euclidian distances of all participants: a) with all eye samples (distribution mean: 71); b) with only initial fixations (distribution mean: 40.5).

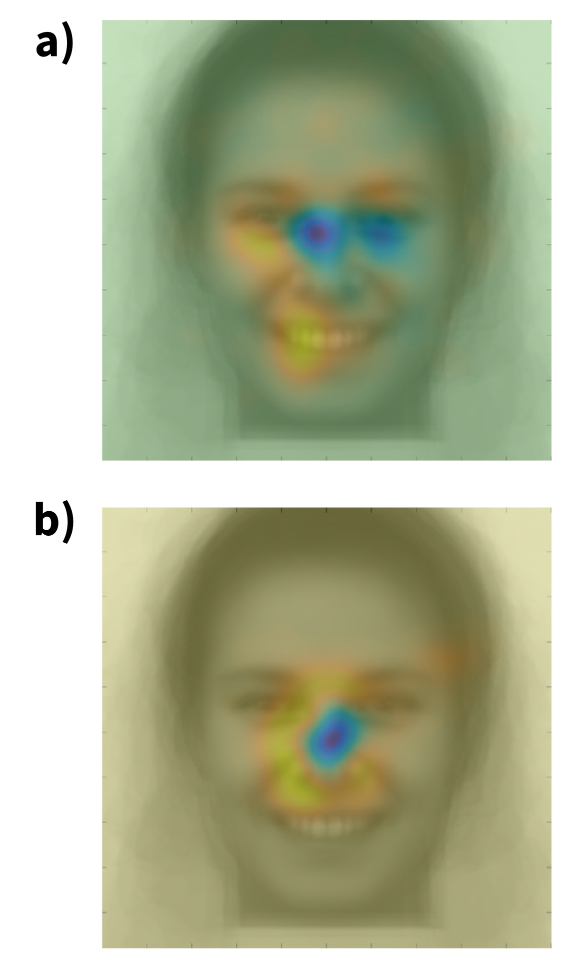

Figure 4 – Fixation bias maps for group 1 (bleu) and group 2 (yellow): a) with all eye samples (group 1: N = 10, average euclidian distances <= 70; group 2: N = 13, average euclidian distances >= 71); b) with only initial fixations (group 1: N = 11, average euclidian distances <= 40; group 2: N = 11, average euclidian distances >= 41).

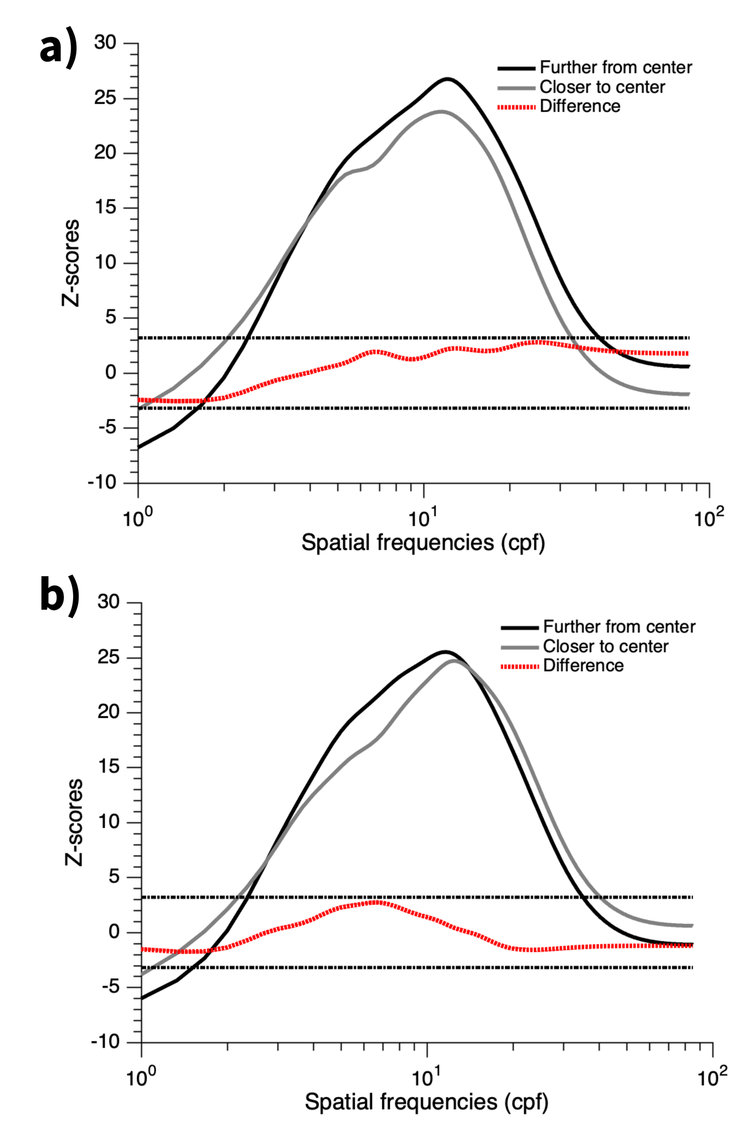

Figure 5 – Spatial frequency tuning of group 1 (gray) and group 2 (black), based on all eye movement samples (a) and initial fixation only (b). Statistical thresholds are represented by dotted black lines (Z_{crit} = 3.2, p<0.025).

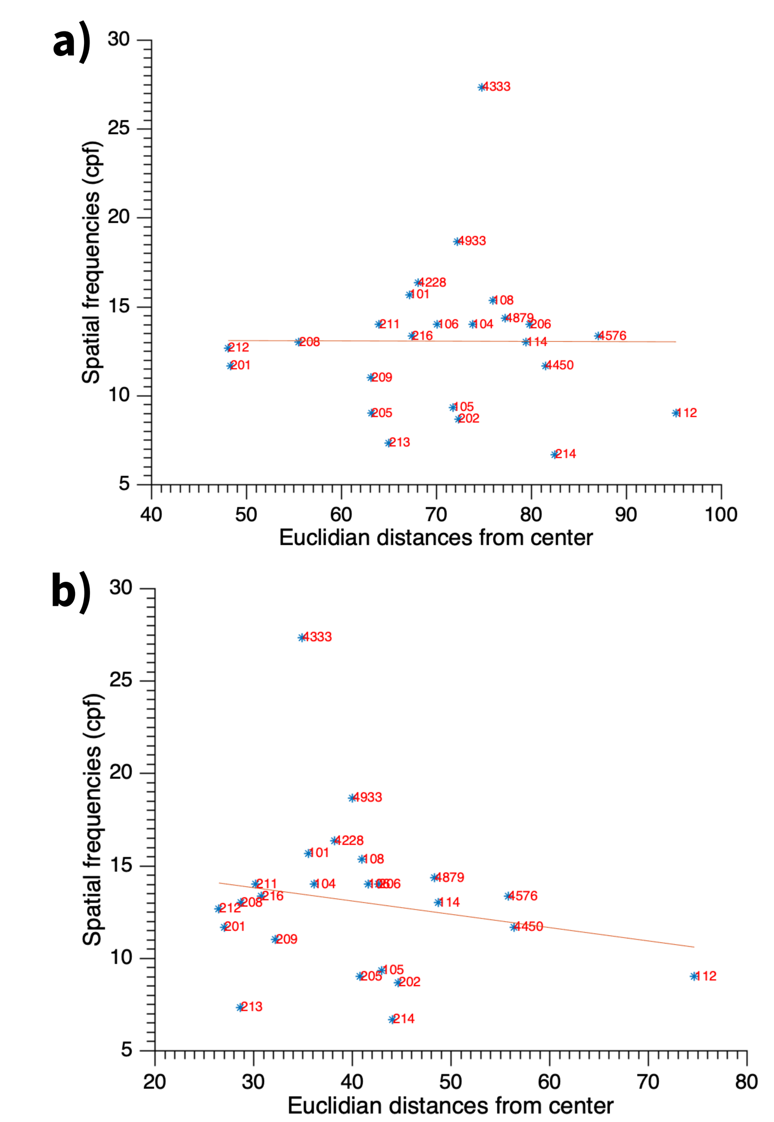

Figure 6 – Linear correlation between participants' average euclidean distances from face center and their SF tuning peaks: a) with all eye samples (r = -0.0039; p = 0.98); b) with only initial fixation (r = -0.1889; p = 0.37).

Discussion

Our data failed to reveal a clear link between eye movement patterns and SF utilization. However, these results are preliminary and more participants will be tested to increase statistical power. Nonetheless, our results highlight that the underlying relation between eye movements and SF use that could possibly drive the previously observed contingencies between these two measures is potentially of a more complex nature.

References

[1] Chuk, T. *et al.* (2014) *Journal of Vision,* 14, 1–14; **[2]** Miellet, S. *et al.* (2011) *Psychological Science*, 22, 1518–26; **[3]** Blais, C. *et al.* (2008) *PLoS ONE*, 3, e3022; **[4]** Tardif, J. *et al.* (2017) *Journal of Experimental Psychology: Human Perception and Performance*, 43, 294-306; **[5]** Estéphan, A. *et al.* (2018) *Journal of vision*, 18, 1121 (abstract); **[6]** Willenbockel, V. *et al.* (2010) *Journal of Experimental Psychology: Human Perception and Performance*, 36, 122-135; **[7]** Lao, J. *et al.* (2017) *Behavior Research Methods*, 49, 559–575; **[8]** Chauvin, A. *et al.* (2005) *Journal of vision*, 5, 1.

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