Visual Information Used for Face Detection Using Bubbles

Laurianne Côté, Alexis Bellerose, Jérémy Lamontagne, Caroline Blais & Daniel Fiset
Department of Psychoeducation and Psychology, University of Quebec in Outaouais

Context

- The ability to perceive faces is essential for social interactions, allowing us to infer age, sex, and emotions and to recognize familiar people. The critical importance of this ability is reflected in the extensive body of research focused on understanding how humans compute the complex information required for those tasks. For example, many have stated that the eyes and mouth regions play a fundamental role in the identification process[1 2 4 5 6].
- However, despite the wealth of research on face recognition, there is a comparative scarcity of publications on the face detection process and the facial information on which it relies. Since face detection serves as the entry point for face processing, a deeper understanding of this mechanism is essential for gaining insights into subsequent stages, such as identity recognition and social cue processing.
- This study aims to identify the facial features most critical for detecting faces, thereby shedding light on the early visual cues that enable effective recognition and social cue interpretation.

Method

Twenty (20) participants (11 women, $M_{age}=22.4$) were tested.

- Participants had to detect faces from "non-face" stimuli (see Figure 1) in two different tasks (see Figures 2A and 2B), with the non-face stimuli consisting of faces that were 100% decomposed with wavelets.
- In both tasks, faces were superimposed with 3D bubbles[3].
- The number of bubbles was adjusted for each participant to maintain a target accuracy level of 75% using QUEST[7].

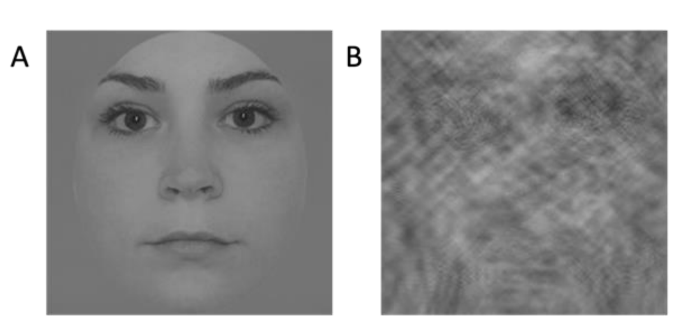

Figure 1 – *A.* Example of a face stimuli. *B.* Example of a non-face stimuli

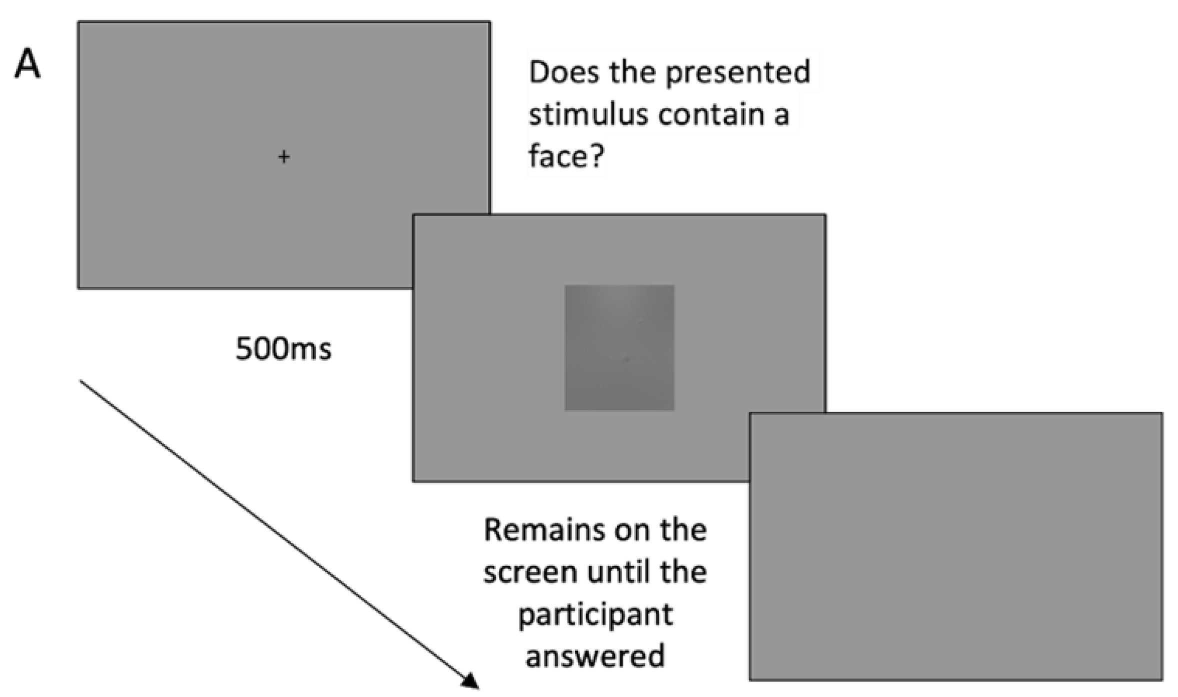

Figure 2 – *A.* Trial procedure for the *face-or-not* task. Participants completed 15 blocks of 100 trials. On average, participants required 12 bubbles to maintain the target performance level.

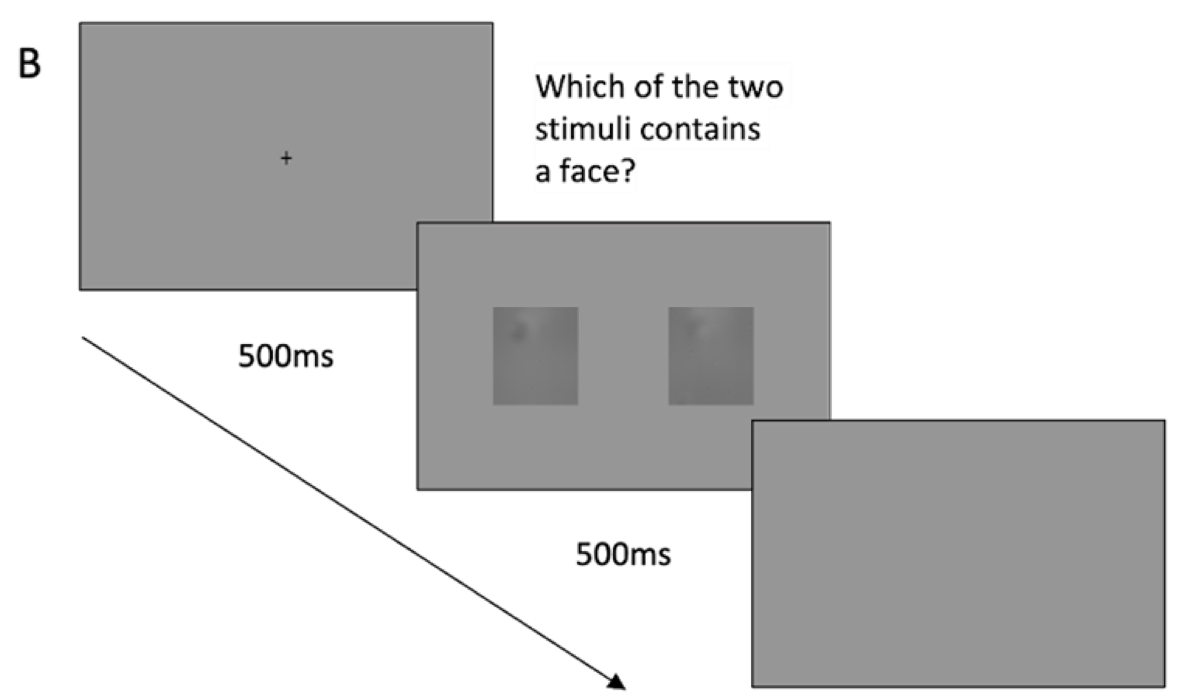

Figure 2 – *B.* Trial procedure for the *face-selection* task. Participants completed 15 blocks of 100 trials. On average, participants required 15 bubbles to maintain the target performance level.

Results

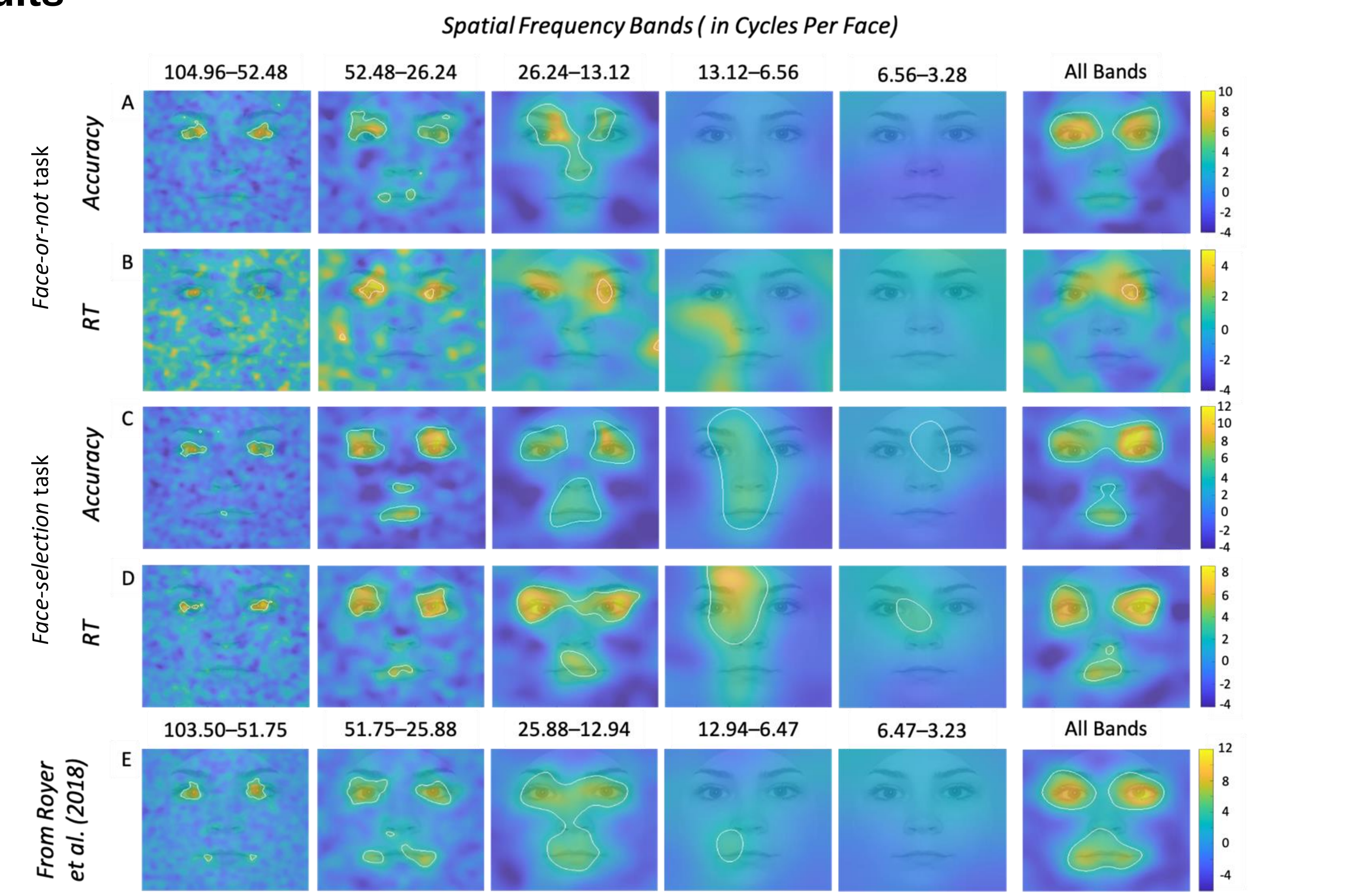

Figure 3 – Classification images of *Face-or-not Task* based on accuracy (A) and reaction times (B) and of the *Face-selection Task* based on accuracy (C) and reaction times (D). Classification images from the identification task conducted in 2018 by Royer and colleagues have been added in E.

Discussion and Conclusion

- Our study identified the eye region as the primary source of information for face detection, with detection performance strongly linked to this area across spatial frequencies, while the mouth region contributed minimally in the face-selection task.
- This pattern mirrors previous findings in face recognition tasks, suggesting that the same facial features may be essential for both detection and identification.
- Given this overlap, it is plausible that prosopagnosic individuals, who often struggle to use the eye region effectively[2 6], might experience challenges with face detection as well. Future research could provide valuable insights by investigating face detection as a potential early-stage deficit in prosopagnosia, which may offer a new perspective on this condition and its impact on face processing.

References

(1) Butler, S., Blais, C., Gosselin, F., Bub, D., & Fiset, D. (2010). Recognizing famous people. *Attention, Perception, & Psychophysics, 72*, 1444–1449. https://doi.org/10.3758/APP.72.6.1444 **(2)** Caldara, R., Schyns, P., Mayer, E., Smith, M.L., Gosselin, F., & Rossion, B. (2005). Does prosopagnosia take the eyes out of face representations? Evidence for a defect in representing diagnostic facial information following brain damage. *Journal of Cognitive Neuroscience, 17*(10), 1652-1666. https://doi.org/10.1162/089892905774597254 **(3)** Gosselin, F., & Schyns, P. G. (2001). Bubbles: a technique to reveal the use of information in recognition tasks. *Vision Research, 41*(17), 2261-2271. https://doi.org/10.1016/S0042-6989(01)00097-9 **(4)** Royer, J., Blais, C., Charbonneau, I., Déry, K., Tardif, J., Duchaine, B., Gosselin, F., & Fiset, D. (2018). Greater reliance on the eye region predicts better face recognition ability. *Cognition, 181*, 12-20. https://doi.org/10.1016/j.cognition.2018.08.004 **(5)** Sekuler, A. B., Gaspar, C. M., Gold, J. M., & Bennett, P. J. (2004). Inversion leads to quantitative, not qualitative, changes in face processing. *Current Biology, 14*(5), 391-396. **(6)** Tardif, J., Morin Duchesne, X., Cohan, S., Royer, J., Blais, C., Fiset, D., Duchaine, B., & Gosselin, F. (2019). Use of face information varies systematically from developmental prosopagnosics to super-recognizers. *Psychological Science, 30*(2), 300-308. https://doi.org/10.1177/0956797618811338 **(7)** Watson, A. B., & Pelli, D. G. (1983). QUEST: A Bayesian adaptive psychometric method. *Perception & Psychophysics, 33*, 113–120. http://dx.doi.org/10.3758/BF03202828

NSERC CRSNG UQO GNSC2 SC2NG LPVS-UQO

lpvs-uqo.ca