N170 and N250 sensitivity to diagnostic facial information during whole-face recognition

Pierre-Louis Audette, Justin Duncan, Caroline Blais & Daniel Fiset
Departement of psychoeducation and psychology, University of Quebec in Outaouais

Context

- In our presentation at VSS2023, we explored the correlation between N170 face sensitivity and diagnostic information processing using a face identification task[1].
- We observed a linear increase in N170 amplitude along with diagnostic information increase (r=-0.98), indicating thorough processing of diagnostic information during face identification.
- However, the amount of facial surface strongly correlated with the amount of diagnostic information (r=0.99), a confounding variable we did not control for.
- The second phase examined whether N170 and N250 reflect the quantity of diagnostic information processed by the brain while keeping the amount of facial surface constant.

Method

- We randomly created sparse facial stimuli with Bubbles[2], and calculated the amount of available diagnostic information using classification images that were previously published[3] as benchmark (Figure 1).
- To equate facial surface across stimuli, bubbles negatives (Fig. 2D) were applied to an average face (2B), substituting non-diagnostic facial information (2F) for masked facial regions (2E). Thus, stimuli always consisted of a whole face (2G).
- Stimuli were divided into twelve bins ranging from 0.01% to 100% information, with an additional 0% condition (i.e., 100% average face) (Figure 3).
- Twelve (12) participants (6 females, M_{age} = 22) first completed two learning phases (1500 trials), which consisted of a face identity recognition task (500 with noiseless faces and 1000 trials using Gaussian white noise variying on a trial basis with QUEST[4] to achieve 75% of correct responses). EEG was then collected during a face identification task (same 10 IDs) that varied the amount of diagnostic facial information (1300 trials/100 per bin) (See Figure 4).

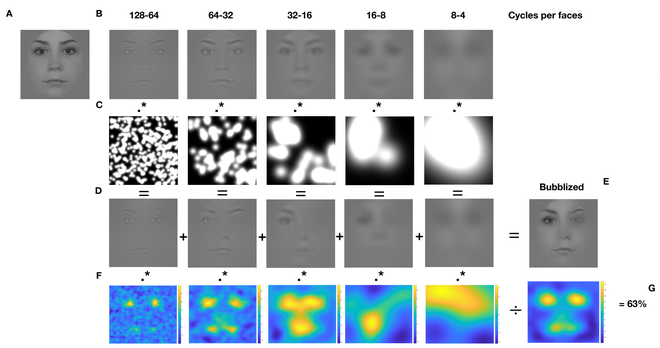

Figure 1. Procedure to create stimuli with the Bubbles method and to calculate the quantity of diagnostic information.

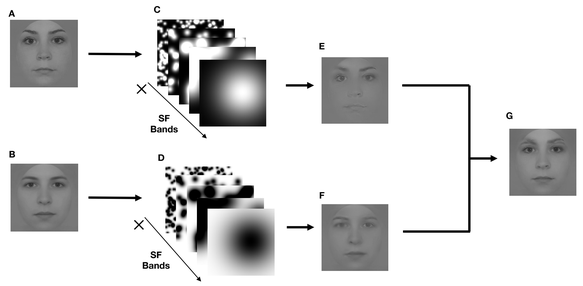

Figure 2. Procedure to standardize facial surface across stimuli using the average face of the 10 identities.

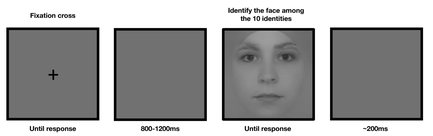

Figure 4. Sequence of events on each trial.

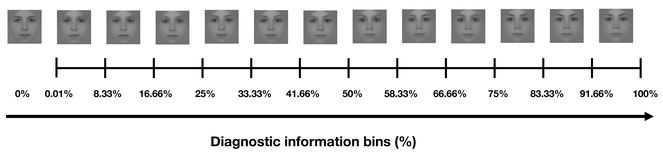

Figure 3. Diagnostic facial information spectrum.

Analyses and results

- Mean ERPs were computed at PO8 for each information bins (Figure 5).
- Mean N170 peak amplitudes showed no significant relationship with diagnostic information, $r_{Pearson}$ = **-0.23; p=0.45.**
- However, mean N250 peak amplitudes expressed a strong relationship with diagnostic information, with N250 amplitude linearly increasing as diagnostic information was increased, $r_{Pearson}$ = **-0.90,** p < 0.001 (Figure 6).
- At the group level, bin-averaged N250 amplitudes strongly correlated with behavioral recognition accuracies, $r_{Spearman}$ = **-0.98**, 95% CI [-0.86; -1], p < 0.001 (Figure 7). This also held on an individual basis, $r_{Spearman}$ = [-0.52; -0.95].

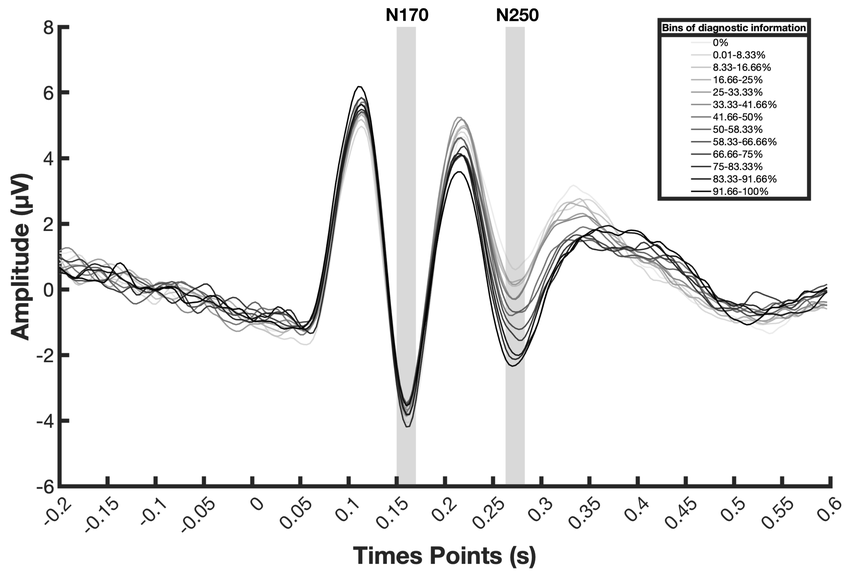

Figure 5. Mean ERP at PO8 for each diagnostic information bins.

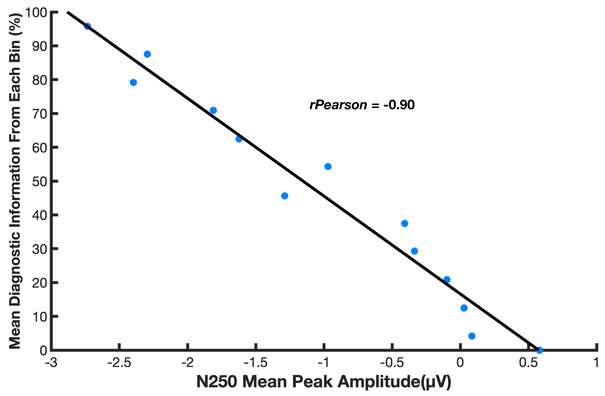

Figure 6. Relationship between mean N250 peak amplitude (μV) and mean diagnostic facial information from each bin (%).

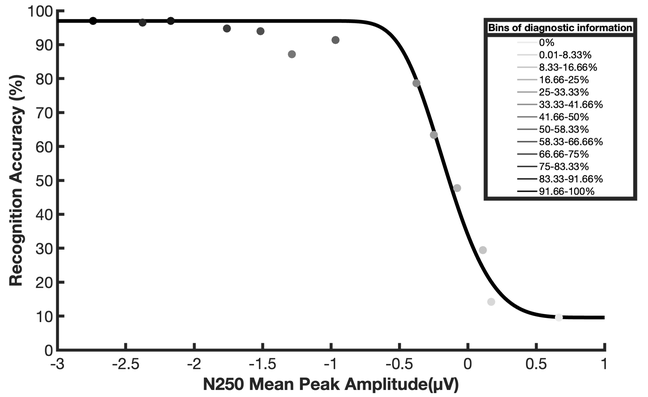

Figure 7. Relationship between mean N250 peak amplitude (μV) and recognition accuracy (%). Curve fitting was applied to best fit this non-linear relationship.

Conclusion

When facial surface is controlled, results suggest a relationship between N250 amplitude, diagnostic facial information processing, and recognition accuracy. As diagnostic information increased, both N250 amplitude and recognition accuracy increased. However, no relationship between N170 amplitude and diagnostic facial information processing was found. Thus, N250 seems to reflect in-depth processing of identity-diagnostic information during face identification, while N170 responds to the ease of categorizing the stimulus as a face.

References. **1)** Audette, P.-L., Duncan, J., Blais, C., & Fiset., D. (2023). Parametric study of N170 sensitivity to diagnostic facial information during face identification. *Journal of Vision, 23*(9), 5077. **2)** Gosselin, F. & Schyns, P. G. (2001). Bubbles: A technique to reveal the use of information in recognition. *Vision Research, 41*; **3)** Royer, J., Blais, C., Charbonneau, I., Déry, K., Tardif, J., Duchaine, B., & Fiset, D. (2018). Greater reliance on the eye region predicts better face recognition ability. *Cognition, 181*, 12-20. 4) Watson, A. B., & Pelli, D. G. (1983). QUEST: A Bayesian adaptive psychometric method. *Perception & psychophysics, 33*(2), 113-120.

lpvs-uqo.ca