Breakthrough Percepts of Differentially Salient Faces: A Fringe-P3 Analysis

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Introduction

The Fringe-P3 technique is an EEG-based method that involves the Rapid Serial Visual Presentation of stimuli to participants (RSVP; Potter, 1976), while monitoring for presentations that elicit the P300 (P3) response, known as the neural signature of salience. This allows for the discovery of information that carries personal significance to participants, without requiring their explicit disclosure of this information (Alsufyani et al., 2017).

While much research has substantiated the reliability of this tool (Harris et al., 2020), few studies have investigated how the P3 response might be affected by variations in the type or strength of the salience associated with the presented stimuli.

In effort to further the current understanding, the present study performs both individual and group-level analyses of EEG data, obtained from an experiment in which participants viewed face stimuli of different forms and strengths of salience. In doing so, our study aims to examine the P3 under a more applicable set of salience conditions, as well as more directly test the utility of this method for use with individual subjects.

Method

Participants

14 students from the University of Kent, with normal/corrected vision, were recruited to the study and compensated £20 for participating.

Materials

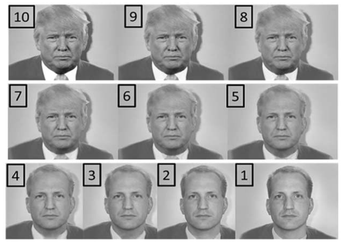
Stimuli

Distractors:
- 560 random, non-salient faces

Targets:
- Donald Trump (inherently salient male)
- Meghan Markle (inherently salient female)
- Random, non-famous male (made incidentally salient through practice block exposure)

Control:
- Random, non-salient face

Figure 1. Target morphs (Trump block)



To operationalise salience strength, morphs of the salient targets were generated by superimposing each over a non-salient face and manipulating their opacity over ten increments, from 10-100%. (See Figure 1). Morphs of the control face were generated in the same way, for fair comparison with the target morphs and valid determination of effects.

Design

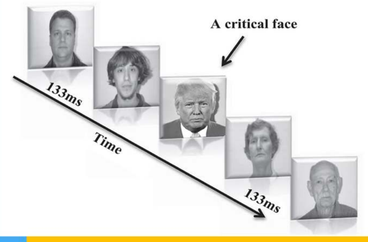
Within-subjects design, four blocks of testing:
1 practice block (10 streams)
- Target: non-famous male (assumed to become incidentally salient)
- Critical faces: 10 morphs of the incidentally salient target.

3 experimental blocks (120 streams)
- Block 1 target: Donald Trump
- Block 2 target: Meghan Markle
- Block 3 target: Incidentally salient face (Block order was randomised)
- Critical faces: 10 morphs of given target/10 control morphs (60 target morph streams, 60 control morph streams, in random order)

Procedure

In each RSVP stream:
1) Target for the given block is presented.
2) Fixation cross (500ms).
3) Stream of 18 faces
   - 17 distractors
   - 1 critical face
4) Report sex of last face in stream (to ensure maintained attention).
5) Repeat for the number of streams in the given block.

Figure 2. Partial RSVP stream (Trump block)



Planned analysis

Preprocessing

- Re-reference to averaged activity at mastoid electrodes
- Band-pass filter (0.3 - 30Hz)
- Segment around events of interest (target/control morph onsets)
- Independent component analysis & artifact rejection
- ERPs generated from averaging responses to critical faces

Data analysis

- Group-level:
  Cluster-based paired-sample permutation tests used to compare ERPs for target morphs, at each salience strength, with ERPs for corresponding non-salient control morphs, across all participants' data.

- Individual-level:

1) Average trial-level ERPs to get trial-level Fully-Flattened Average (FuFA).
2) Use one sample t-test to determine FuFA significance (FuFA vs. 0).
3) If significant, use FuFA as region of interest for individual-level effect. Cluster-based permutation-versions of independent two-sample t-tests used to compare ERPs for critical morphs, at each salience strength, with ERPs for corresponding non-salient control morphs, within each participant's individual data.

Results

Using data from seven of the 14 total participants tested, a preliminary analysis, conducted by the original experimenter, showed distinct patterns of responding to faces of different types and strengths of salience. As would be expected, stronger P3s were found for inherently salient faces than for incidentally salient faces, and the strengths of the inherent-salience P3s appeared to correspond to the salience strengths of the stimuli from which they were elicited. Although a different pattern of activation is seen in the incidental salience condition, the higher salience signals appear to partially follow this trend. We propose that with the inclusion of the full dataset, we may be able to see a comparable, albeit weaker, signal pattern from the incidental-salience P3s.

Figure 3. ERPs at Pz (Trump condition)

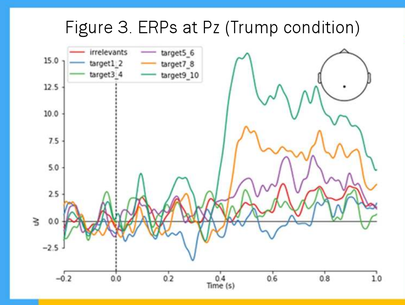


Figure 4. ERPs at Pz (Markle condition)

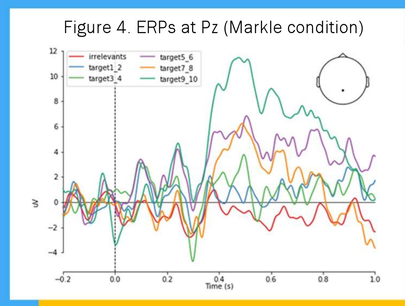
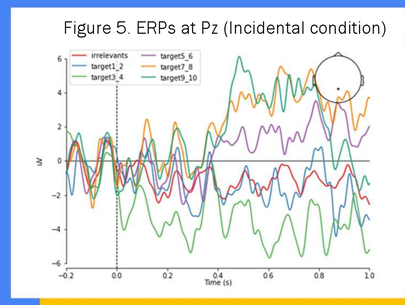


Figure 5. ERPs at Pz (Incidental condition)



Discussion

- This work could have potentially important implications for real-world applications such as forensic services or healthcare, where a tool to reliably detect incidental salience could communicate important information that might otherwise be difficult to retrieve.

- By investigating the P3 response at different strengths of salience, we may be able to determine the point at which individuals become aware of the salience of stimuli, and whether any unconscious processes occur, prior to this point.

- Through the incorporation of an individual-level analysis, our study may offer key insight into the applicability of the Fringe-P3 technique for single-subject salience-detection, which the breadth of existing research, focusing on group-level analyses of this phenomenon, cannot explicitly comment on.

References

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- Potter, M. C. (1976) Short-term conceptual memory for pictures. *Journal of Experimental Psychology: Human Learning and Memory, 2*(5), 509–522.