Does the predicted reward/non-reward difference wave uniquely relate to variability in trait extraversion?

Cornish, T. and Pickering, A.

Research Questions

The general reward processing theory of extraversion suggests that the trait's attributed tendencies can be partially explained by differential reward processing within the mesolimbic system (Smillie et al., 2019). An event related potential (ERP), known as feedback related negativity (FRN), has been shown to be a plausible index of the dopamine associated reward prediction error (RPE) - which encodes information regarding whether a stimulus met a previously learnt expectation, or not (Smillie et al., 2019).

Smillie and colleagues (2019), recently substantiated the existence of a unique relationship between extraversion and the differential processing of reward predictions; indicated via the FRN – elicited after the presentation of an unexpected stimulus (S2) -- RPE index. The current study will seek to directly replicate this finding.

Pickering & Pesola (2014), modelled individual differences in phasic dopaminergic activity in response to expected/unexpected rewards/non-rewards within the mesolimbic system. Their simulations suggest the 'predictive' ERP elicited by the presentation of a cue (S1), that is predictive of a reward or non-reward indicator (S2), could be a greater predictor of trait extraversion than is the RPE FRN that proceeds the onset of an unexpected S2. Holroyd et al., (2011), found the predictive difference wave (which is the predicted reward ERP minus the predicted non-reward ERP) was large and significant. This study will seek to evaluate Pickering & Pesola's (2014) prediction and replicate Holroyd and colleague's (2011) underpowered (N = 18) findings.

H1: The S1 elicited predicted difference wave will be significantly different from zero.

H2: The S1 elicited predicted difference wave will be positively and uniquely associated with extraversion.

H3: The feedback related negativity elicited after the presentation of S2 will be a significant and a unique positive predictor of extraversion.

Methods

The acquired data consists of 100 participants from the University of Melbourne community. All participants were compensated with $23 for their participation and completed three measures thought to capture individual difference in extroversion: the big Five Aspect Scales (BFAS), the big Five Mini Markers (MM) and the Multidimensional Personality Questionnaire (MPQ).


Pickering & Pesola (2014)
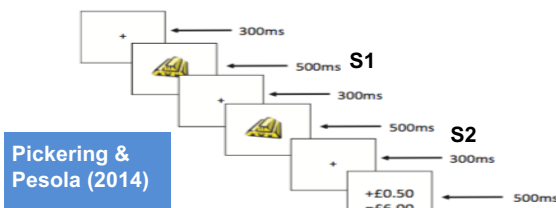
Participants were subject to a focal learning task that required they passively observe visual stimuli that either predicted the giving of a reward or non-reward, whilst EEG data from the medial frontal channels were recorded. This culminated in six trial types.

1) Predicted reward or non-reward (S1)

2) Expected reward or non-reward (i.e. S1 == S2)

3) Unexpected reward or non-reward (i.e. S1 ≠ S2)

Analysis

ERPs elicited by the presentation of S1 and S2 will be derived from 600ms epochs for each corresponding trial type. An unexpected difference wave (RPE index) will be calculated by subtracting the unpredicted reward ERP from the unpredicted non-reward ERP.

Additionally, a predicted difference wave will be calculated by subtracting the predicted reward ERP from the predicted non-reward ERP. A paired t-test we be employed in order to evaluate whether the predicted difference wave differs significantly from zero.


Holroyd et al., (2011)
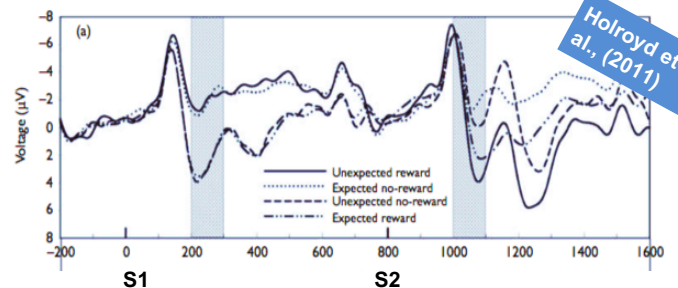
Two separate multiple regression analyses will be employed, with all domain level personality traits entered as predictors in both. Outcome variable 1) FRN (unexpected difference wave) proceeding S2, 2) predicted difference wave proceeding S1.

Expected Results

1. The unexpected feedback related negativity elicited after S2 will be shown to be a unique predictor of extraversion. This finding will be indicative of differential reward processing partially underpinning trait extraversion.

2. The predictive difference wave (elicited after S1) is likely to be significant, however, the effect size is not expected to be as large (Cohen's D = 4.55) as reported by Holroyd et al., (2011).

3. Pickering & Pesola's (2014) prediction, that the predicted difference wave will account for a significant portion of individual difference in trait extraversion, is expected to be substantiated in the current study.

Data from the first participant.
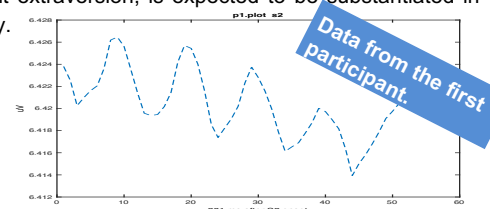
References

Holroyd, C. B., Krigolson, O. E., & Lee, S. (2011). Reward positivity elicited by predictive cues. *Neuroreport*, *22*(5), 249-252.

Pickering, A. D., & Pesola, F. (2014). Modelling dopaminergic and other processes involved in learning from reward prediction error: contributions from an individual differences perspective. *Frontiers in human neuroscience*, *8*, 740.

Smillie, L. D., Jach, H. K., Hughes, D. M., Wacker, J., Cooper, A. J., & Pickering, A. D. (2019). Extraversion and reward-processing: Consolidating evidence from an electroencephalographic index of reward-prediction-error. *Biological psychology*, *146*, 107735.