Processing reward magnitude and valence: Dissociations and Individual differences in the FRN and P300

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Background

Yeung and Sanfey[1] showed that (1) positive and negative feedback (i.e., valence) elicit different FRN amplitudes: greater for losses than wins, and (2) that the P3 differentiated the magnitude of the reward but not the valence. Thus, they showed a double dissociation between FRN/P300 and valence/magnitude of feedback.

The FRN valence sensitivity has been replicated a number of times using similar tasks[2, 3, 4,5] but also that the P3 is sensitive to both magnitude and valence of the feedback.[2, 3, 4] These components have proven useful in marking participants' responses to feedback in general. Furthermore, the neural generators for the FRN have been localized to the ACC[6] which is connected with the OFC and other motivational and reward related areas.

However, feedback effects on the FRN and P3 may vary with personality or temperament variables, because the biological bases of personality or temperament overlap with the reward-related circuitry.[7,8] Furthermore, personality traits have been shown to be related to various ERP components.[9]

Our goal was to further examine the FRN/P3 dissociation as well as evaluate the role of individual differences in the processing of this feedback.

Method

Participants:

- 30 participants (age M = 22, SD = 2.82)
- 23 undergraduate students, 18 were female
- 14 did not report engaging in gambling activities

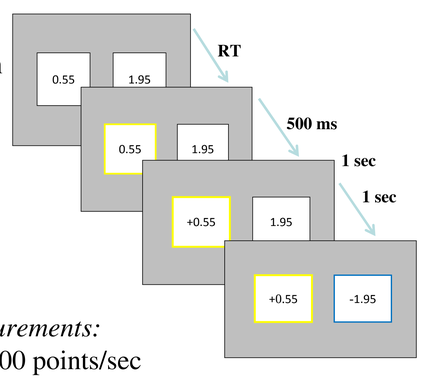
Self-report questionnaires:

- Sensation seeking scale – a 40 item scale consisting of experience seeking, disinhibition, boredom susceptibility and thrill/adventure seeking
- Sensitivity to reward/Sensitivity to punishment– a 48 item scale; how much behaviour is driven by desire to obtain rewards and worry about punishment and failure

ERP Task:

Participants chose between 2 cards. After the choice, the valence of the card is revealed

- 5 blocks, 64 trials/block
- Length: ~ 25 min

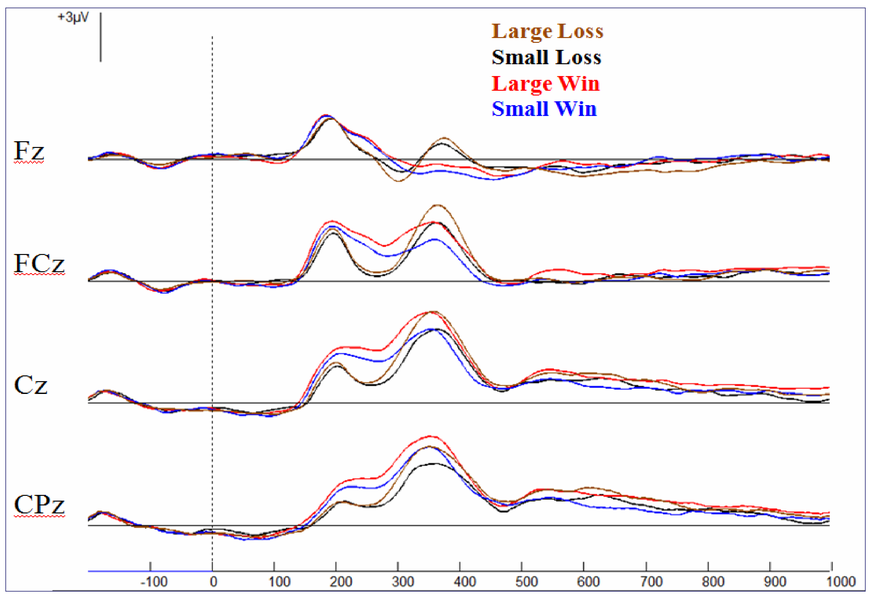


Electrophysiological measurements:

- 128 site EGI system, 500 points/sec
- 4 midline sites were scored: Fz, FCz, Cz, Pz
- ERPs time-locked to the presentation of valences of the chosen card with 200 ms pre-stimulus baseline

Results

Figure 1. Average stimulus-locked ERP waveforms for the four feedback conditions.



Valence:

- Losses were elicited larger amplitude of FRN (F (1,28) = 9.08, p = .005) and P300 (F (1,28) = 25.64, p < .001) across the midline sites (Fz, FCz, Cz, CPz)
  - ➢Strongest effect for the FRN amplitude was at FCz ($p\eta^2$ = .49)
  - ➢Strongest effect for the P3 amplitude was at Fz ($p\eta^2$ = .21)

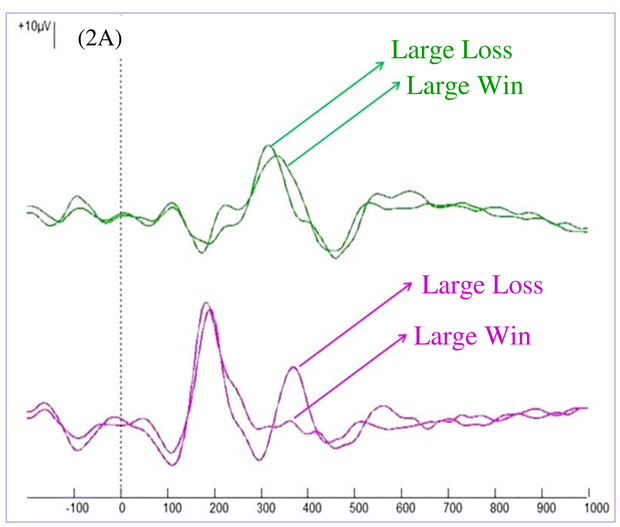
Magnitude:

- Feedback for large amount elicited larger amplitude of the FRN (F(1,28)= 27.86, p < .001) and P300 (F(1,28) = 95.8, p = .023) across the midline sites
  - ➢ Strongest effect for the FRN amplitude was at Cz ($p\eta^2$ = .32)
  - ➢Strongest effect for the P3 amplitude was at Cz ($p\eta^2$ = .48)

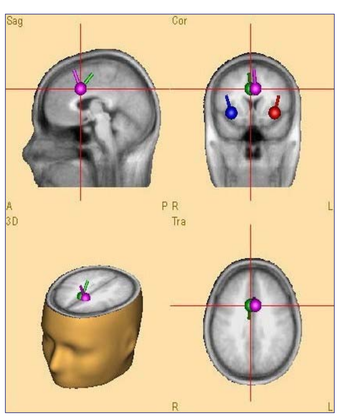
Dipole analysis conducted using BESA:

- Two symmetric dipoles in the dorsal anterior cingulate cortex (ACC)
- One active only in the loss condition, pointing toward Fz
- Another active in both win and loss conditions, pointing toward Cz

Figure 2. Dipole models of the large loss and large win conditions: (A) overlay of the source waveforms; location and projections of each dipole in 3D space (B)



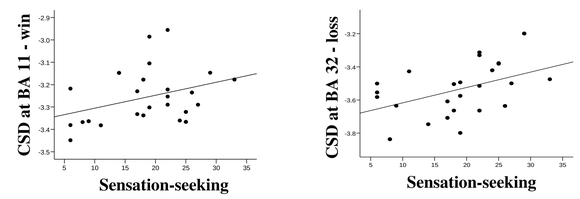
(2B) Dipole models in **large loss** condition at 364 ms post-stimulus presentation



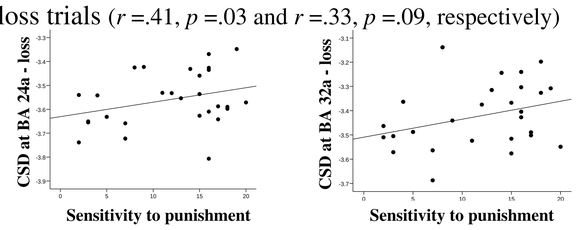
Results (cont'd)

Relationships between current source density obtained from LORETA analyses and individual differences

- Higher sensation seeking ~ higher activations in
  - BA 32 (ACC) on loss trials (r =.44, p =.027)
  - BA 11 (mPFC/OFC) on win trials (r =.36, p =.08)
  - BA 10 (mPFC) on win and loss trials (r = .42 and .45, p< .05)



- High sensitivity to punishment also relates to higher activations in dorsal and rostral ACC (BA 24a and BA 32a) on loss trials (r =.41, p =.03 and r =.33, p =.09, respectively)



Conclusions

1) Valence and magnitude are processed separately in the brain
   - Account for different variance in ERP components
   - Different dipole activations
   - No double dissociation between scalp ERP components and characteristics of feedback

2) Feedback on reward-related paradigm is associated with the activity of dorsal ACC and mPFC

3) Personality differences are associated with differential activations of reward-related neurocircuitry, especially ACC and mPFC/OFC

Magnitude and valence are dissociable in the brain; however, this independence is not simply in terms of the ERP component and can be influenced by personality

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