Living (and Dying) in the Moment: An Examination of Ongoing Neural Activity During Social Exclusion

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Abstract
Social exclusion is known to cause alterations in neural activity as well as perceptions of social distress. However, previous research is largely limited to examining neural activation aggregated within blocks of social interactions, which does not allow for the examination of adjustments in neural alarm activity, or task-relevant attentional processes, during social interactions. To address these limitations, we examined neural activity and other attention-related neural processes on a trial-by-trial basis during different social interactions that were characterized as largely inclusive or exclusionary. Our results show neural activity during social inclusion, evidenced by the N2 component, in response to all exclusionary events, even during inclusionary interactions. Further, we show that the explicit allocation of attention toward an exclusionary experience, indexed by the P3b, is associated with self-reported social distress while the mere activation of the neural alarm is not; implying that neural alarm activation is not specific to prolonged exposure to social exclusion and related social pain. Finally, during the exclusionary interaction, both the N2 and P3 showed larger amplitudes in the earlier stages of exclusion compared to the later stages, suggesting heightened early sensitivity for both components, and P3 amplitude was larger to exclusionary events compared to the two inclusionary interactions, indicating a contextual influence of exclusion.

Results
Social Exclusion Manipulation
- As expected, participants reported feeling less positive mood, having less fulfillment of their social needs, and feeling more ignored in the exclusionary interaction compared to the inclusionary interactions (Fs(2, 20) ≥ 6.1, ps ≤ .008, partial η2 ≥ .38).

Neural Measures
- Both N2 and P3 amplitude showed amplitude differences for exclusionary throws compared to inclusionary throws regardless of the overall context of the social interaction, with:
  - larger (more negative) N2 amplitude and smaller (less positive) P3 amplitude for exclusionary throws compared to inclusionary throws.
  - P3 amplitude to exclusionary events was larger in the exclusion block of the Cyberball paradigm compared to the two inclusionary blocks (inclusion, re-inclusion).
- Both N2 and P3 were larger for the first 20 exclusionary throws compared to the second 20 exclusionary throws once the complete exclusion began during the exclusion block of the Cyberball paradigm.
- Neither N2 nor P3 amplitude showed a main effect for block. However, because more exclusionary events would be aggregated together in the exclusion block, the aggregated total of N2 activation would be greater in the exclusion block, corroborating Eisenberger et al. (2003, 2007).

Conclusion
This study examined the relation between social exclusion and event-related brain potentials. Results indicated differences in neural activation to specific events within social interactions, regardless of the larger contexts of the interactions. Specifically, we found neural alarm activation, indexed by the N2, to exclusionary throws during inclusionary interactions. This event-related activation did not differ in magnitude to the activation evidenced during social exclusion and was present in the absence of self-reported social distress. Further, differences in the allocation of attention, indexed by the P3, were identified within the larger context of the social interactions, with greater attention paid to exclusionary events when they occurred during exclusion compared to inclusion. Additionally, the modulation of the P3 from inclusion to exclusion was associated with the modulation of self-reported social distress from inclusion to exclusion. Finally, patterns of neural activation changed over the course of the ongoing exclusion experienced during the exclusion block, with heightened neural activity earlier, compared to later, in the exclusion. These findings suggest that discrete events occurring during a social interaction may provide additional insights into social exclusion compared to more global inclusionary or exclusionary classifications of social interactions.

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