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## Abstract


Being the target of social exclusion produces a number of negative consequences, including deficits in cognitive functioning related to self-regulation and general cognition. While such effects have been acknowledged, there is a lack of literature examining the influence of social exclusion on both neural and behavioral indices of self-regulatory action monitoring processes during task performance. Accordingly, the current study utilized event-related brain potentials (ERPs) to investigate the influence of social exclusion, created through the use of the Cyberball paradigm, on neural and behavioral indices of self-regulatory action monitoring processes implemented during the execution of a modified flanker task. Specifically, the study examined the error-related negativity (ERN), a neural index of self-regulation following performance errors, and post-error response accuracy, a behavioral indicator of the ability to correct behavior. Results indicated that participants who were excluded during the Cyberball paradigm showed subsequent decreases in both ERN amplitude and post-error response accuracy following social exclusion. Conversely, participants who were not excluded during Cyberball evidenced greater ERN amplitude and improved post-error response accuracy following the Cyberball interaction. These findings suggest that self-regulatory action monitoring processes, including the ability to effectively detect and correct performance errors during task execution, are compromised following the experience of being excluded from a social interaction.


## Procedure

### Cyberball Paradigm

- Participants took part in an online game of catch, called Cyberball (Williams et al., 2000), that is pre-programmed to include or exclude participants.
- Participants were randomly assigned to be fully included throughout the game (Inclusion group) or completely excluded from the game following an initial inclusionary phase (Exclusion group). In each interaction, the human participant was represented by the hand at the bottom of the screen.
- Before and after each block of Cyberball participants completed a feelings and social needs questionnaire (NTS) and the PANAS questionnaire.

### Modified Flanker Task

- Participants completed a modified version of the flanker task, where congruent and incongruent trials were equiprobable and randomly ordered.

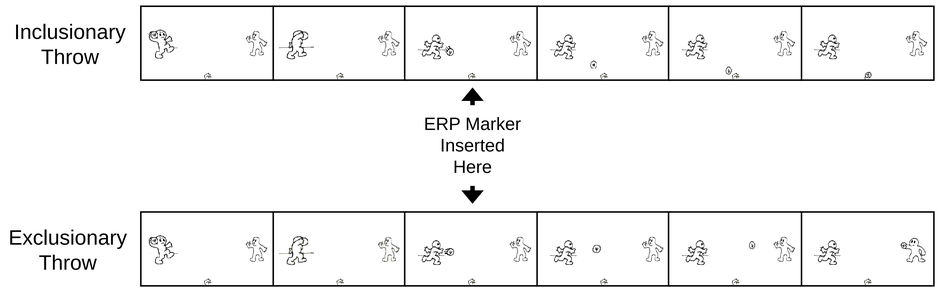
Congruent: <<<<< or >>>>>

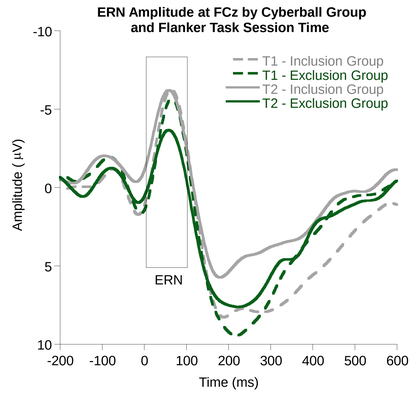
Incongruent: <<><< or >><>>

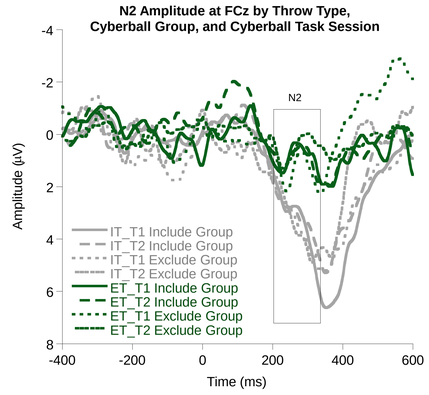
- Two blocks of 600 trials were administered to participants both before (T1) and after (T2) the Cyberball paradigm (totaling four blocks of 600 trials each).

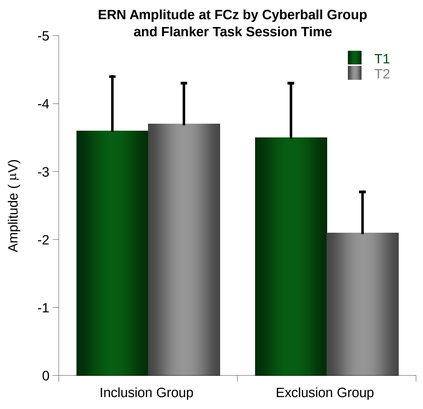
### Neuroelectric Assessment

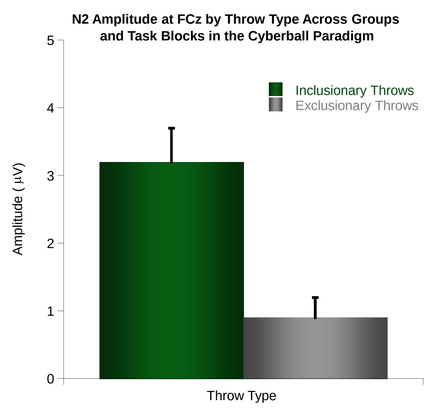
- EEG activity was measured from 64 midline and lateral sites.
- ERN amplitude was quantified as the average activity from 0 – 100 ms in the response-locked ERPs at the FCz electrode site.
- The ERN was measured during the flanker task both before and after the Cyberball manipulation to make comparisons between pre- and post-Cyberball ERN amplitudes.
- N2 was quantified as the average negative deflecting amplitude between 200-350 ms post-stimulus at the FCz electrode site.
- The stimulus was defined as the first informational frame in the ball toss that indicated where the ball was being thrown in Cyberball. Throws to the participant were defined as inclusionary throws and throws to the computerized players were defined as exclusionary throws (see top figure).

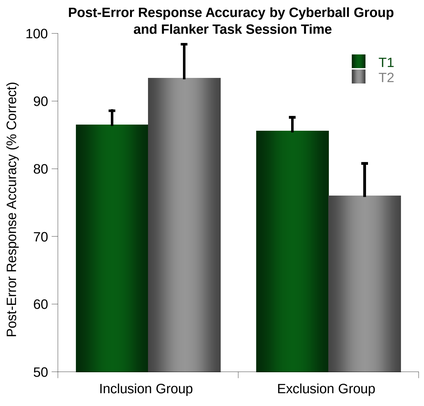


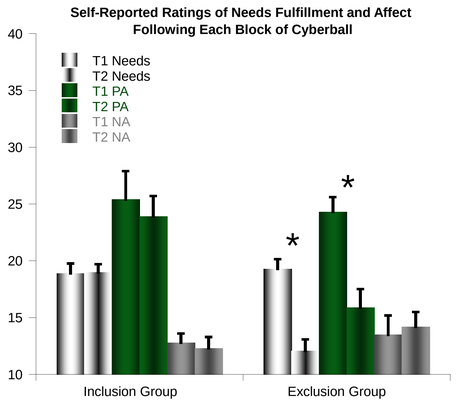




## Results

### Flanker ERN

- Analyses revealed a significant time × group interaction for the ERN, with larger (more negative) ERN at T2 compared to T1 for the inclusion group and smaller ERN at T2 compared to T1 for the exclusion group.

### Flanker Post-Error Accuracy

- A significant time × group interaction was found, with an increase in post-error accuracy from T1 to T2 for the inclusion group, but a decrease in post-error accuracy from T1 to T2 for the exclusion group.

### Relation between ERN and Post-Error Accuracy

- The correlation between changes in ERN and post-error accuracy over time was significant across all participants, $r = -.43$, $p = .04$, suggesting that as ERN changed to be more negative (larger) across task sessions post-error accuracy changed to be greater (more accurate) regardless of participants' Cyberball group assignment.
  - This provides evidence that the decrease in ERN for the exclusion group was associated with worse post-error response accuracy across task sessions, just as the improvement in post-error accuracy for the inclusion group was seen without a decrease in ERN.

### Cyberball N2

- Analyses revealed a main effect of throw type, indicating larger (more negative) N2 amplitude for exclusionary throws compared to inclusionary throws regardless of Cyberball task block or participant group assignment. No other significant effects were present.
  - Importantly, because more exclusionary events were aggregated together during exclusion compared to inclusion, the aggregated total of N2 activation would be greater during the exclusion block.

### Cyberball Self-Report

- Analyses revealed a significant time × group interaction, with participants in the exclusion group reporting less fulfillment of their social needs after their exclusionary interaction compared to all other measurements on all scales for either group.
- For the PANAS, the positive affect scale showed a similar time × group interaction, but the negative affect scale showed no significant effects.

## Conclusion

This study investigated the relationship between social exclusion and action monitoring in healthy young adults. Results indicated that social exclusion negatively impacted both neural and behavioral indices of self-regulatory action monitoring processes during subsequent cognitive task execution. More specifically, we found decreased ERN amplitude and no changes in post-error response accuracy across task sessions for participants who had previous experienced social exclusion. However, ERN amplitude was not changed and post-error accuracy increased across task sessions for those participants who were included in social interactions. These findings suggest that action monitoring is among the self-regulatory cognitive functions which are negatively impacted by social exclusion. This decrease in self-regulatory performance is likely due to "cognitive deconstruction," which is the reallocation of cognitive processes to the investigation of the exclusionary social interaction. Accordingly, these findings not only provide support for the existence of a neural alarm system in response to social exclusion, but they also suggest that occurrences of social exclusion may serve to deplete one's capacity to tolerate the attentional effort and sacrifices needed for effective self-regulatory action monitoring during subsequent cognitive task engagement.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