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Neural Effects of Varying Levels of Social Re-Inclusion After Varying Periods of Social Exclusion

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Abstract

This thesis studied the effects of social ostracism on individuals. Specifically, how conditions of exclusion and various levels of re-inclusion affect participant's responses in terms of social pain and neural activation due to exclusion. Participants played a Cyberball paradigm (Williams et al., 2000), developed to include and exclude the participant. Participants were assigned a varying condition of exclusion and then re-inclusion during the computerized social interaction. Event-related brain potentials in response to the game were measured via electroencephalography. It was hypothesized that the degree of exclusion would influence P3b and N2 neural activation elicited in response to the exclusion, and that complete exclusion would cause different patterns of neural activation and greater exclusion-related social distress compared to partial exclusion. Additionally, it was thought that partially excluded and then completely re-included participants would record lower P3 and N2 neural activation than those partially re-included, and in complete exclusion, level of re-inclusion would not alter recorded level of reported social distress. Dependent measures were neural activation and survey responses. Our results showed that neural activity is affected by the degree and condition of exclusion occurring during ongoing social interactions, with partial re-inclusion resulting in greater neural conflict and attentional allocation. Results will contribute to understanding the effects of ostracism, as well as provide information as to whether specific levels of social re-inclusion alleviate social pain caused by exclusion.

"Hey, Elliot Rodgers here, I am up in the hills of Montecito right now, it is truly a beautiful day, but as I have always said, a beautiful environment is the darkest hell if you have to experience it all alone, and sadly, I have been alone for a very long time… (Elliot Rodgers, 2014)"

The transcript above was taken from a video 22 year-old Elliot Rodgers posted before murdering multiple people in Isla Vista, California. During his killing spree, Elliot injured 13 people and took the lives of eight, including his own. From the 137-page manifesto discovered after his death, it was evident his motivation resulted from a twisted perception that society, and particularly women, had consistently excluded and rejected him. In his writings, there were clear signs of mental instability, as well as a possible undiagnosed Personality Disorder; however, Elliot writes that it was the exclusion he felt from society that drove him to take such inhumane measures (Rodgers, 2014). Elliot's case was dramatic, but evidence has shown that exclusion can have detrimental emotional effects (Williams, 2001). Exclusion is universal; almost every person has experienced some form of exclusion in his or her lifetime (Williams, 2001). For example, think about how it would feel to walk into a room for the first time and have no one acknowledge your presence. Most people would say this experience would make them sad or result in some type of emotional pain. These feelings occur because exclusion causes negative and debilitating psychological effects, such as sadness, low self-esteem, and emotional distress (Ondo et al., 2010; Themanson et al., 2014; Williams, 2009). Because of this, current studies have spent considerable efforts trying to understand the negative effects of exclusion and researching the neurological and emotional factors involved in social exclusion (Eisenberger et al., 2003; Themanson et al, 2014; Williams, 2001; Zadro et al., 2004).

INTRODUCTION

Defining Social Exclusion

Previous studies have defined social exclusion as the process of leaving out or rejecting an individual from a social group (Gruter & Masters, 1986). It has also been described as the act of ignoring another, usually without any explanation on the part of the excluder (Williams, 2009a). Additionally, exclusion has been expressed as the explicit isolation of an individual (Williams, 2009a). For this study, social exclusion was defined as the process of purposefully leaving out another individual. This definition was chosen because it provided a simple explanation, yet also demonstrated intentionality. Exclusion, regardless of its definition, has been shown to be an extremely painful and distressing experience (Themanson et al., 2014; Wessleman et al., 2009; Williams, 2009; Williams, 2009b).

Humans, History, and Evolution in Regards to Exclusion

Social exclusion is suspected of having evolutionary roots; it has impacted civilizations for centuries, and can be found in many different social and governmental infrastructures. Researchers have found examples of exclusion throughout history, as well as in a variety of cultures (Gruter & Masters, 1986; Williams, 2009a; Williams & Nida, 201). Records have showed Athenians voting on the banishment of individuals, with exiles usually lasting around 10 years (Williams, 2009; Zippelius, 1986). Within the animal kingdom, primates, lions, and wolves practice exclusion, as exclusion decreases the chances of interbreeding and brings more DNA into the genetic pool (Williams, 2001). For example, older male lions that cannot fight to protect their pride will become outcasts, forced to roam the bush in solitude. Additionally, animals have shown to practice exclusion during a migration or when resources are low, such as excluding disabled individuals or overly dependent youth, because it increases the group's chances for survival (Williams, 2001).

Members with deviant or maladaptive behaviors could put the entire group at risk; therefore, excluding these individuals in order to protect the group has evolutionary benefits (Wesselmann et al., 2012; Wesselmann et al., 2013; Williams, 2001; Williams, 2009). However, even though exclusion has proven adaptive for the group, individuals have a better chance of survival when apart of a group (Williams, 2001). Humans have an innate desire to maintain an attachment to a group, as well as an inherent ability to notice or predict initial signs of exclusion (Williams & Nida, 2011; Williams, 2009a). When an individual is excluded, the feeling of connection toward a social group is severed, which causes an increase in anxiety (Williams, 2009a). This is problematic because humans have an internal motivation to form and maintain human bonds (Baumeister et al., 1995; Williams, 2007; Williams, 2009b). Therefore, the negative emotions felt by the excluded individual serve to motivate changes in behavior as an attempt to regain acceptance into the group (Wesselmann et al., 2013; Williams, 2000; Williams & Nida, 2011). Therefore, exclusion, rejection, and social disapproval have become evolutionary tools used to ensure that members of a group adhere to certain standards.

Modern societies have used exclusion as an instrument to maintain social order (Wesselmann et al., 2013; Williams, 2000; Williams & Nida, 2011). In this way, exclusion has served as a deterrent for deviant behavior and a motivator for obedience towards societal rules and group norms (Wesselmann et al., 2013; Williams & Nida, 2011) For example, many legal and governmental systems utilize exclusion as a means to ensure certain behavioral norms are followed; the threat of exclusion may encourage members to maintain a certain level of decorum or follow group laws (Gruter & Masters, 1986; Zippelius, 1986). Jails use solitary confinement, another form of exclusion, as a punishment for inmates who violate prison rules (Gruter & Masters, 1986). Additionally, the act of expulsion and suspension in schools can also be viewed as a form of social exclusion (Williams, 2009; Zippelius, 1986). It may seem that since exclusion is commonly practiced within modern societies it should not be detrimental to humans; however, it has been shown to have negative psychological effects.

Sense of Belonging and Need-Threat Theory

A variety of social constructs have utilized social exclusion; therefore, it is important to understand its detrimental effects. A great deal of cognitive processing is involved in cultivating social relationships, and social bonds have been shown to influence emotional states (Baumeister et al., 1995). While acceptance elicits positive feelings, exclusion causes negative feelings to develop (Baumeister et al., 1995). In fact, exclusion causes such social distress that participants in an exclusionary game study, who were told the game was just for fun, still reported low scores in measures of self-esteem, belonging, and meaningful existence (Zadro et al., 2004). These results show that regardless of the condition, social exclusion results in harmful, negative emotions (Zadro et al., 2004).

Exclusion has shown to threaten four core needs: belonging, self-esteem, control, and meaningful existence (Williams, 2007; Williams, 2009b). The need for a sense of belonging originated from the idea that individuals need at least a few friends, as well as a few long-term, stable, and frequent social interactions in order to live a happy and fulfilled life (Baumeister et al., 1995). This need is correlated with self-esteem, as self-esteem serves as an internal measurement for sense of belongingness. Therefore, high self-esteem indicates that one feels he or she has a secure social place within his or her group (Williams, Forgas, & von Hippel, 2005). In addition to having a high self-esteem, individuals need to feel they can have an impact on their surroundings, as this sense of control decreases anxiety. Finally, the need for a meaningful existence is important to humans as it reinforces the idea that one's life has purpose (Williams, Forgas, & von Hippel, 2005).

Reactions to exclusion depend on what needs are most threatened. Threats to belonging and self-esteem may influence an individual to use pro-social behavior as a means to regain acceptance in a group; whereas threats to personal control and purpose in life may lead individuals to choose aggressive behavior or become hostile towards social groups (Williams, 2007; Williams, 2009b). Additionally, exclusion has shown to result in an internal battle between threatened needs and cause a decrease in self-regulation, even when individuals have no chance of seeing the excluder again (Jamieson et al., 2010; Williams, 2007; Williams, 2009b). In fact, participants falsely told they would never find a mate, were more likely to choose high-risk behavior over healthy behavior, suggesting the prospect of living in solitude decreases motivation to uphold healthy long-term behaviors or to live a quality life (Twenge et al., 2002). This is possibly due to depleted coping skills (Williams, 2011). Elliot Rodger's aggressive reaction to exclusion may have resulted from his need for control and meaningful life being threatened. His desire for retribution became greater than his desire to assimilate into society, which can occur in overtly ostracized individuals (Williams, 2009a).

Pain as a Result of Exclusion

Elliot Rodger's story provides a prime example of the emotionally agonizing impact exclusion has on humans; therefore, understanding the role of emotional pain in social exclusion is vital. Neural activity elicited as a result of physical pain is also activated during emotional distress due to social exclusion. Neural activity for emotional pain and physical pain are indexed in the same neural area (Eisenberger et al., 2003). fMRI studies showed the dorsal Anterior

Cingulate Cortex (dACC) is activated for both physical pain and emotional distress (Eisenberger et al., 2003; Williams, 2009a). dACC activation was related to distress experienced during an exclusionary period (Masten et al., 2013), implying that the neurocognitive substrates employed during physical pain are also activated during emotional pain due to exclusion (Eisenberger, 2011). Neural mechanisms involved in social pain were also activated by the mere observance of exclusion, demonstrating that just overseeing exclusion elicits emotional pain (Eisenberger et al., 2003). Additionally, individuals who had previously been excluded had greater dACC activity while watching another person be included, suggesting that witnessing another person being included after personally experiencing exclusion may cause greater social distress (Masten et al., 2013). Pain associated with social rejection could be adaptive as it may serve as an alarm system that warns individuals of possible exclusion, and influences individuals to steer clear of any situations or actions that may lead to social exclusion (Eisenberger, 2011). The experience of pain from social rejection may motivate individuals to maintain their connection with the group (Eisenberger, 2011; Williams, 2009), as mentioned before, various neural mechanisms are responsible for monitoring these reactions (Eisenberger et al., 2003; Williams, 2009a).

The Anterior Cingulate Cortex (ACC) and its Role in Exclusion

The dorsal anterior cingulate cortex (ACC) is activated during social exclusion and plays an important role in understanding the neurological effects of exclusion (Eisenberger et al., 2003; Themanson et al., 2013). The ACC, located in the medial prefrontal cortex (Folstein et al, 2008), is central to the limbic system and the frontal lobe's connection pathways (Fuster, 2009). Information is processed in different modules within the ACC, which utilize sensory or response selection as a means to regulate attention and executive functions (Bush et al., 2000). The dorsal side of the ACC is involved primarily in cognitive processes, where the rostral-ventral side is utilized during affective processing (Bush et al., 2000); however, at times the dACC has integrative functions, involving both cognitive control and negative affect (Spunt et al, 2012), which may explain neural excitation in regards to pain. Tasks that are emotionally dense, sad or have information in competition with one another, such as those involving exclusion, activate the ACC (Fuster, 2009).

The ACC is known to be involved in cognitive control and conflict monitoring (Allman et al., 2000; Braver et al., 2001; Fuster, 2009; Miller & Cummings, 1999), and is activated as a sign to exert control in the presence of conflict (Botvinick et al., 2001). In exclusionary situations, conflict driven ACC excitation has shown to result from an increased frequency of exclusionary acts that are aggregated over an entire social interaction (Themanson et al, 2013). Thus, in exclusionary experiences, activation could develop from behavior and desire contradictions, as a participant wants to be included, but continually experiences isolation. This activation may occur in many different situations, outside of artificial lab studies (Themanson et al., 2013). This notion was supported by additional research, suggesting that the cognitive monitoring system has more generalized functions than previously thought, and should not be considered context or situation-specific, but rather seen as involved in more generalized self-regulatory needs that exist across tasks and paradigms (Themanson et al., 2014).

Behavior is adjusted based on previous performance, thus the ACC has the ability to regulate and monitor action, signaling when a behavior needs correction (Botvinick et al., 2001; Fuster, 2009). The ACC alarm system may act as a regulator, warning when there are contradictions in behavior or if an outcome conflicts with what was wanted. It then initiates cognitive control to change behavior and reach a desired end (Botvinick et al., 2001; Spunt et al., 2012; Themanson et al., 2013). This response is adaptive because it serves as an evaluative and regulatory system, enabling individuals to be aware of exclusion, and determine if a change in behavior is necessary to regain access into the group (Themanson et al., 2013; Williams, 2009a). Exclusion may indicate hardship, and therefore, negative feelings that result from exclusion may motivate a change in behavior (Zadro et al., 2014). This source of conflict regulation might bring attention to divergences, and thus initiate cognitive control as a means to modify behavior (Fuster, 2009; Themanson et al., 2013).

In sum, evidence has suggested that exclusion creates neural conflict, as well as social, emotional, and cognitive consequences for the targets of exclusion. Individuals, after becoming aware of their own exclusion, will attempt to take the appropriate measures in order to regain access into the group (Zadro et al., 2004). Interestingly, the ACC was shown to elicit event related negativity during exclusion. This activation was indexed by the anterior N2 component, which is an event – related potential (Themanson et al., 2013; Themanson et al., 2015).

Understanding Event-Related Potentials

In this study, event-related brain potentials (ERPs) were used to measure neural activity during social exclusion, thus a basic understanding of their function is important. ERPs are neuroelectric responses to specific stimuli associated with various brain structures (Duncan et al., 2009; Sur & Sinha, 2009). They are time-locked with specific events, initiated at any time from 50 ms to over a second after stimulus presentation. ERPs represent the excitation of post-synaptic potentials, which occur during the processing of information when cortical pyramidal neurons have elicited simultaneously (Duncan et al., 2009; Sur & Sinha, 2009). For the ACC, event-related activation is captured through assessing the anterior N2 component (Themanson et al., 2013; Themanson et al., 2015). In this paper, I will talk about anterior N2 and P3b components in relation to exclusion-related ERPs.

P3b, N2, and Their Role in Exclusion

Social exclusion has shown to activate both P3b and the N2 (Kawamoto et al., 2013; Themanson et al., 2013; Themanson et al., 2015; Weschke et al., 2013). Both these components play an important role in determining the neural effects of social exclusion. P3b is an endogenous ERP component, meaning that its excitation depends upon attentional allocation and processing of a stimulus (Linden, 2005). Thus, the more attention a stimulus has received or the more discriminative a stimulus, the higher the amplitude (Linden, 2005; Sur & Sinha, 2009). P3b activation occurs approximately 200-400 ms after stimulus presentation and is larger during specific exclusionary moments, demonstrating greater attention to exclusionary action (Themanson et al., 2013; Weschke et al., 2013).

In exclusionary situations, P3b is involved in processing whether one is going to be included, and determining the participant's personal probability of being included (Weschke et al., 2013). P3b provides a foundation for normal versus abnormal cognition, and is elicited when something seems out of place, has more significance, or is less likely to occur, making it useful for indicating irregular behavior in exclusionary studies (Polich, 2003). The P3b has also been shown to elicit during oddball tasks (Linden, 2005; Polich, 2003; Sur & Sinha, 2009). During an oddball task, two stimuli are presented, and the participant must discriminate the frequent non-target stimulus from the infrequent target stimulus. P3b is elicited when the infrequent target stimulus is presented, demonstrating how it is activated (Polich, 2003).

Attentional allocation variation, indexed by the P3b between inclusionary and exclusionary interactions, was associated with changes in self-reported levels of distress from inclusion to exclusion (Themanson et al., 2013). This suggests levels of social distress presented early in exclusion is similar to those reported during inclusionary conditions because attentional control is not fully activated yet. P3b amplitude is also higher during the first half of the exclusion condition and then decreases during the second half (Kawamoto et al., 2013; Themanson et al., 2013; Themanson et al., 2015), implying that initial signs of exclusion elicit the strongest reactions, but once the participant becomes accustomed to the rejection the over activity subsides. Further, because feelings of social distress result from attention to exclusionary events, a wide variety of exclusionary situations might elicit social distress, not just artificial lab-based versions of completely exclusionary interactions (Themanson et al., 2013).

As mentioned previously, the activation of the ACC is indexed by the anterior N2 component and is thought to have a role in cognitive control and conflict monitoring (Themanson et al., 2013; Sur & Sinha, 2009), making it a useful component to measure in exclusionary studies. In oddball tasks containing go/no-go trials, anterior N2 elicited during the presentation of frequent non-target stimulus (Folstein et al., 2008). The non-frequent target stimulus was associated with a "go" response, and the frequent non-target stimulus the "no-go" response. "No – go" targets elicited larger anterior N2 activation, increasing in amplitude as the probability of "no-go" targets decreased, demonstrating that N2 was activated in response to the probability of stimulus presentation (Folstein et al., 2008), and providing evidence that N2 was regulated by discerning mismatches between the stimulus that was presented and a mental schema for the situation. During exclusion, neural activation is sensitive to the specific situation occurring during an interaction, rather than just the larger picture of the interaction (Folstein et al., 2008;Themanson et al., 2013). Specifically, exclusionary events elicited greater N2 activation, engaging the conflict monitoring neural alarm system (Themanson et al., 2013). These indices of conflict appeared during both inclusionary and exclusionary interactions, suggesting that they were not dependent upon feelings of distress or exclusion as an overall experience (Themanson et al., 2013; Weschke et al., 2013).

CURRENT STUDY

The purpose of this study was to compare neural activity resulting from periods of social exclusion with neural activity during conditions of social re-inclusion. Research has shown that individuals who experience re-inclusion after periods of exclusion recover from emotional distress faster than those who experience no re-inclusion (Themanson et al., 2013). However, the amount of re-inclusion necessary to experience full emotional recovery remains unknown. The goal of this study was to examine how various levels of exclusion, followed by various levels of re-inclusion, affect the participant's neural activation as a measure of emotional recovery. We used electroencephalography (EEG) to examine neural activity during social exclusion and analyzed patterns of event-related brain (ERP) activation. ERPs measure participants' neural activity during the entire task, and can record specific neural events occurring during the social inclusion and exclusion task using informational markers that note every time the ball is thrown.

For this research project, we used Cyberball. Cyberball is a computer game developed to study social exclusion. Participants were engaged in a game of toss between other computer generated "players". At a certain point, the participant became excluded from the game and the computer generated "players" only threw the ball to one another (Williams et al., 2012). This study was separated into two blocks, each with four different conditions (two conditions for each gender). The conditions for block 1 were complete exclusion and partial exclusion. After the initial 10 throws, participants in the partial exclusion condition had a low probability of receiving the ball. Participants in the complete exclusion condition did not receive the ball at all after the initial 10 throws. Conditions in the second block included: complete re-inclusion and partial re-inclusion. Participants in the partial re-inclusion were moderately re-included into the game. Participants in the complete re-inclusion conditions returned to complete re-inclusion. All of the participants completed questionnaires before and after each block. Neural measurements were recorded using EEG analysis software, and the N2 and P3b components were observed.

We hypothesized that the degree of exclusion would influence P3b and N2 neural activation elicited in response to the exclusion, and that complete exclusion from a social interaction would lead to different patterns of neural activation and greater exclusion-related social distress compared to partial exclusion. Additionally, we predicted that during a social interaction, those participants who were partially excluded, but then completely re-included, would record lower levels of exclusion-related P3b and N2 neural activation than those who are partially re-included. For those who are in the complete exclusion condition, we hypothesized the level of re-inclusion would not alter the participant's recorded level of reported social distress. This pattern of findings was predicted because complete exclusion should be more emotionally intense and harmful in terms of need threat than the partial-exclusion condition. Accordingly, any degree of re-inclusion would lead to decreases in self-reported social pain because there would be less conflict, and thus less need to allocate attention towards how one can be re-included.

This study was important for understanding the effects of exclusion on individuals, and provided information on the impact of re-inclusion after a period of exclusion on neural activity. These results serve as a reference between the differences in partial-exclusion and complete exclusion in terms of neural activity measured by the EEG, and may lay a foundation for new hypotheses to be developed regarding the effects of inclusion. The study found supportive evidence on the positive effects of re-inclusion on previously excluded individuals, and provided insight on how various degrees of exclusion can lead to significant social pain in individuals. Additionally, it may enable society to gain a better understanding of the effects of exclusion and re-inclusion, and whether or not specific levels of re-inclusion are able to alleviate some of the social pain caused by varying levels of exclusion, as well as influence the neural activity associated with being excluded.

Methods

Participants

Fifty-eight general psychology students from Illinois Wesleyan University, between the ages of 18 and 22, were recruited for this experiment: 38 females and 20 males. Students received research credit towards a General Psychology class requirement as compensation for their participation. Participants who did not fully complete the study (i.e., did not complete both task sessions, missing questionnaire data) were discarded from the analyses, as were participants with excessive noise and artifacts obtained during event-related brain potential (ERP) data collection, resulting in a sample size of 48 participants (30 females, 18 males). The study received Internal Review Board approval from Illinois Wesleyan University.

Procedure and Measures

Upon arrival, participants were given an informed consent and asked to complete a number of questionnaires. The questionnaires were the following: Edinburgh handedness questionnaire (Oldfield, 1971), the need-threat scale (NTS; Williams et al., 2000), Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), State Trait Anxiety Inventory (STAI, Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), Beck Depression Inventory (Beck, Steer, & Brown, 1996), International Personality Item Pool Scale (Goldberg et al., 2006), Social Phobia and Anxiety Inventory (Connor et al., 2000), Rejection Sensitivity Questionnaire (Downey et al., 1996), and Ten Item Personality Measure (Gosling et al, 2003). On average, participants completed the first set of questionnaires in about a half an hour.

After finishing the questionnaires, participants were given a brief overview of the study. Researchers then began putting the EEG cap on the participant. Our lab followed the International 10-20 system for placing electrodes. Quick-gel was used to fill the lycra cap. To make sure the entire electrode was filled completely, we looked at the impendence of the signals on the Neuroscan. Once all the electrodes were filled, the EEG application was complete and participants were told about the computer program, Cyberball (Williams et al., 2000). The participants were told they would be playing an online game of catch with two other students, one located at Illinois State University and the other located at the University of Illinois at Urbana-Champaign. However, these other students were actually computer-generated through the Cyberball computer program (Williams et al., 2000). We used this deception in order to simulate the experience of real-world exclusion. The participant was given a remote and told to respond with button presses to determine where the ball should be thrown after they received the ball. Pressing the left button would pass the ball to the left, and a right button press would pass the ball to the right. The research assistant also explained the rules regarding the EEG.

Once the participant was ready to begin, the researcher returned to the stimulus computer room to start block 1, the exclusionary block of the Cyberball paradigm. Upon entering the room, the researcher filled out the participant's stimulus sheet in order to determine which conditions the participant would be randomly assigned for each block. Through the manipulation, block 1 contained two possible exclusion conditions for each gender (partial exclusion and complete exclusion), and block 2 contained two possible inclusionary conditions for each gender (partial re-inclusion and complete re-inclusion). Therefore, there were four possible sequence pairings:

PE_PI (partial exclusion/partial re-inclusion), PE_CI (partial exclusion/complete re-inclusion), CE_PI (complete exclusion/partial re-inclusion), CE_CI (complete exclusion/complete re-inclusion).

During the Partial Exclusion (PE) condition for block 1, the participant had a 50% chance of receiving the ball for the initial 10 throws. However, after the initial 10 throws, the participant's likelihood of receiving the ball was reduced to 20% for the rest of the game. This occurred because the participant was being partially excluded. During the Complete Exclusion (CE) condition for block 1, the participant has a 50% chance of receiving the ball for the initial 10 throws. However, after the initial 10 throws, the participant did not receive any more throws for the rest of the game. This occurred because the participant was being completely excluded.

During the Partial Re-inclusion (PI) condition for block 2, the participant returned to a 35% chance of receiving the ball. This occurred because the participant was being partially re-included. However, during the Complete Re-inclusion (CI) condition for block 2, the participant returned to a 50% chance of receiving the ball. This occurred because the participant was being completely re-included. Male participants always played with other male computer generated students. Female participants were paired with female computer generated students. This was done to avoid any confounds associated with gender differences. Therefore, the experiment was not completely random. During the game, event-related markers were recorded on the computer program collecting ERP data. These markers appeared every time the ball was thrown, and enabled researchers to determine the type of neural activity that occurred when the throw was inclusionary (to the participant) or when it was an exclusionary (thrown to the other "student").

After the researcher had determined the participant's assigned condition pairings for each block, the researcher inputted the appropriate file information for block 1 into the stimulus computer and started the Cyberball program as well as the EEG data recording for block 1. After the first block had concluded, the participant's screen was turned off and they were asked to take the PANAS and STAI again. The PANAS was used to measure mood changes as a result of exclusion, and the STAI was used to measure alterations in anxiety between the blocks. During this time, the research assistant set up the second block in the computer room. After the participant had completed the second PANAS and STAI, the researcher inputted the information for block 2 into the stimulus computer and started the Cyberball program and the EEG data recording for block 2. During block 2, ERP data was collected again. After the participant had completed the second block, the EEG cap was removed and the participant was asked to complete another set of questionnaires, including the PANAS and STAI. Once this was completed, the participant was debriefed and thanked for their participation. The entire session lasted about 120 minutes.

Neuroelectric assessment.

A lycra cap with 64 sintered Ag–AgCl electrodes sewn into it was used to record the electroencephalogram (EEG). For the EEG recording, an average-ear reference and forehead ground (AFZ), were utilized during the recording, and eye movements were accounted for by recording vertical and horizontal bipolar electrooculographic (EOG) activity. The raw EEG signal was digitized (500 Hz sampling rate) and low-pass filtered (30 Hz; 24 dB/octave) by Neuroscan Synamps2 bioamplifier (Neuro Inc., El Paso, TX, USA). Stimulus-locked ERP activity was processed offline and involved blink correction, which was accomplished by a spatial filter (Compumedics Neuroscan, 2003), generation of stimulus–locked epochs (800-2500 ms relative to the marker), baseline removal (800ms pre-stimulus interval), as well as artifact rejection (epochs with signal that exceeded +75mV were rejected). The average amplitude within the discrete latency window (200 to 320 ms) after the event marker was used to measure the N2 component at the FCz electrode site, as this is where N2 is maximal and has been observed in previous studies (Themanson et al, 2013). The P3b component was also measured by average amplitude in the discrete latency window, but ran from 320 – 450 ms after the event marker and was recorded at the Pz electrode site, as P3b is typically observed partially and has been observed in this location in previous studies (Themanson et al, 2013). Neuroscan Scan Software (v4.3.1) was used to record activity from the EEG. Neuroscan Stim (v2.0) software managed the presentation of the stimulus, as well as documentation and timing of Cyberball responses from participants.

Statistical Analyses

A 2 (time: block 1, block 2) x 4 (group - PE_PI, PE_CI, CE_PI, CE_CI) mixed-model ANOVA was used to analyze the N2 component at the FCz site and the P3b component at the Pz site. For all analyses, $p < .05$ was the alpha level. An ANOVA or *t*-test was conducted to determine the nature of the data for any significant interactions in the neuroelectric or behavioral variables.

Results

Behavioral Measures

To ensure that the Cyberball paradigm worked as planned and participants were engaged in the social manipulations, analyses of participants' self-reported feeling states following each Cyberball block were conducted. The omnibus 2 (time: block 1, block 2) × 4 (group) mixed-model ANOVAs for self-reported measures completed following each block of Cyberball (NTS, PANAS) revealed the expected main effect for time on most scales of the NTS, $F's(1, 44) \geq 6.0$, $p's \leq .02$, partial $\eta^2 \geq .12$, as being excluded (first block) is worse for individuals in terms of their needs fulfillment (NTS) compared to varying levels of social inclusion (second block). Further, in terms of the PANAS, participants reported less positive affect, $F(1, 44) = 3.8$, $p = .05$, partial $\eta^2 = .08$, and more negative affect, $F(1, 44) = 5.2$, $p = .027$, partial $\eta^2 = .11$, following the first block compared to the second block of Cyberball. The scale on the NTS that did not show a main effect for time was the need for control scale, a subscale for NTS, which showed a significant time × group interaction effect, $F(3, 44) = 3.6$, $p = .02$, partial $\eta^2 = .20$. Using paired-samples *t* tests to look at need for control scores across time for each group, analyses revealed a significant increase in the fulfillment for the need for control in the group of participants who were first completely excluded and then partially re-included (CE_PI), $t(11) = 3.2$, $p = .008$. No other groups exhibited significant time effects.

Neural Measures

N2 Component. An omnibus 2 (time: block 1, block 2) × 4 (group) mixed-model ANOVA for exclusionary events within the Cyberball paradigm showed a significant main effect for time $F(1, 44) = 12.28$, $p = .001$, partial $\eta^2 = .22$.with larger (more negative) N2 amplitude for exclusionary events in the first Cyberball block ($M = .3$ µV, $SD = 1.4$) compared to the second Cyberball block ($M = 1.1$ µV, $SE = 1.8$) regardless of group. This main effect was modified by a significant time × group interaction effect, $F(3, 44) = 2.84$ $p = .049$, partial $\eta^2 = .16$. Please see Figure 3 for a comparison for N2 amplitude at the FCz site during blocks 1 and 2 . Using paired-samples t tests to look at the N2 across time for each group, analyses revealed that the group of participants who were first partially excluded and then completely included (PE_CI) exhibited significantly smaller (less negative) N2 amplitudes in the second Cyberball block ($M = 1.7$ µV, $SD = 1.3$) compared to the first Cyberball block ($M = .2$ µV, $SD = 1.0$). No other groups exhibited significant time differences in N2 amplitude after Bonferroni correction, t's $(11) \leq 2.5$, p's $\geq .03$.

More generally, the interaction seems to be carried by the group of participants who were partially excluded and then partially included (PE_PI) as they revealed a N2 amplitude that was larger (more negative) in the second Cyberball block (M = -.2 μV, SD = 2.0) compared to the first block (M = .1 μV, SD = 1.2) whereas all three other groups of participants had N2 amplitudes that were smaller (more positive) in the second Cyberball block (PE_CI: M = 1.7 μV, SD =1.3; CE_PI: M = 1.7 μV, SD = 1.9; CE_CI: M = 1.0 μV, SD = 1.1) compared to the first block (PE_CI: M = .2 μV, SD =.9; CE_PI: M = .9 μV, SD = 1.1; CE_CI: M = -.3 μV, SD = 1.6). There was no significant main effect for group. Please see Figure 3 for a comparison for N2 amplitude at the FCz site during blocks 1 and 2, and Figure 4 to see the ERP components highlighting the N2 component at FCz.

P3 Component. An omnibus 2 (time: block 1, block 2) × 4 (group) mixed-model ANOVA for exclusionary events within the Cyberball paradigm showed that P3b had a significant main effect for time $F(1, 44) = 4.11$, $p = .049$, partial $\eta^2 = .09$ with larger (more positive) P3b amplitude for exclusionary events in the second Cyberball block (M = .6 μV, SD = 2.7) compared to the first Cyberball block (M = .1 μV, SE = 2.4), regardless of group. This main effect was modified by a significant time × group interaction effect, $F(3, 44) = 3.66$ $p = .019$, partial $\eta^2 = .20$. Please see Figure 5 for a comparison for P3b amplitude at the Pz site during blocks 1 and 2 .Using paired-samples *t* tests to look at the P3b across time for each group, analyses revealed no significant time differences in P3b amplitude across time for any group after Bonferroni correction, *t*'s $(11) \leq 2.7$, p's $\geq .02$. More generally, the interaction seems to be carried by the different directions of change in the P3b across blocks. The groups of participants who were partially excluded in the first block (PE_PI: M = .5 μV, SD = 2.7; PE_CI: M = -.5 μV, SD =1.9) showed larger (more positive) P3b amplitudes in the second block (PE_PI: M = 2.1

μV, SD = 3.6; PE_CI: M = .1 μV, SD =1.8), whereas participants who were completely excluded in the first block (CE_PI: M = 1.4 μV, SD = 1.9; CE_CI: M = -.8 μV, SD =2.8) showed smaller (more negative) P3b amplitudes in the second Cyberball block (CE_PI: M = .7 μV, SD = 2.6; CE_CI: M = -.4 μV, SD =2.5)). There was no main effect for group for the P3b. Please see Figure 5 for a comparison for P3b amplitude at the Pz site during blocks 1 and 2, and Figure 6 to see the ERP components highlighting the P3b component at Pz.

Discussion

Social exclusion is psychologically debilitating and causes harmful, negative emotions for the person experiencing it (Williams, 2001; Zardo et al., 2004). Exclusion also threatens four core needs: belonging, self-esteem, control, and meaningful existence (Williams, 2007; Williams, 2009b). Research has shown periods of social re-inclusion following periods of social exclusion leads to quicker emotional recovery than no re-inclusion (Themanson et al, 2013). However, the exact amount of re-inclusion necessary to reduce emotional distress remains unknown. The current study examined how the conditions of exclusion and the various levels of re-inclusion affect a participant's responses in terms of feelings of social pain and their neural activation due to the exclusion.

Neural Responses

This study showed that neural activity is affected by the degree and condition of exclusion during ongoing social interactions. This supports our hypothesis that the degrees of exclusion and subsequent re-inclusion would influence P3b and N2 neural activation elicited in response to the exclusion. Specifically, this study's results show an increase in amplitude in the N2 component, which is associated with increased conflict monitoring, in the PE_PI group

(Partial Exclusion –Partial Re-inclusion). In all the other groups, PE_CI (Partial Exclusion, Complete Re-inclusion), CE_PI (Complete Exclusion, Partial Re-inclusion), and CE_CI (Complete Exclusion, Complete Re-inclusion), the N2 amplitude decreased, or became more positive. These results suggest that the conflict-driven N2 activation is still present, and even increased, during the second block for the PE_PI group, which supports our hypothesis that partially excluded, but then completely re-included participants, would exhibit lower levels of exclusion-related P3b and N2 neural activation than those who are partially re-included.

These results correspond with previous research, showing exclusionary events elicit greater N2 activation, engaging the conflict monitoring neural alarm system (Themanson et al., 2013). Conflict driven activity of the ACC, indexed by the amplitude of the N2, is known to be involved in cognitive control and conflict monitoring (Fuster, 2009; Botvinick et al., 2001; Braver et al., 2001; Allman et al., 2000; Miller & Cummings, 1999;), and is elicited as a sign to exert control in the presence of conflict (Botvinick et al., 2001). In exclusionary situations, conflict driven ACC excitation may result from an increased frequency of exclusionary acts that are aggregated over an entire social interaction (Themanson et al., 2013). The larger level of neural conflict in the PE_PI condition may have resulted from a mismatch between the reality of the situation (i.e., the inconsistent exclusion followed by the inconsistent re-inclusion) and the participant's mental schema of how the situation should play out (i.e. constant inclusion). Participants in the PE_PI condition experienced ambiguous exclusion in the first block, and then noncommittal re-inclusion in the second block. Greater N2 amplitude could be the result of the participant's desire to be fully included in both blocks not being fulfilled and conflict persisting regarding the social standing of the participant. Research has suggested that neural activation during exclusion could develop from behavior and desire contradictions, as a participant wants to be included, but continually experiences isolation (Themanson et al., 2013). Therefore, conflict may have been greater for the PE_PI block because the participant is unsure about their social standing from the Partial Exclusion condition, and the Partial Re-inclusion condition does not resolve enough of the conflict to result in a significant change in N2 excitation, or awareness of conflict.

This notion is supported by the fact that participants in the complete exclusion conditions CE_PI (Complete Exclusion, Partial Re-inclusion), and CE_CI (Complete Exclusion, Complete Re-inclusion), show less N2 activation in the second block, suggesting that after experiencing complete exclusion, any form of re-inclusion, whether it is complete re-inclusion or partial re-inclusion, is enough to fulfill a sense of belonging and lower sense of conflict. This supports our hypothesis that for those in the complete exclusion condition, the degree of re-inclusion would not alter the participant's recorded level of reported social distress. The results suggest that any degree of re-inclusion would lead to decreases in self-reported social pain in terms of exclusion for those who experienced complete exclusion, as the threat to needs is greater in complete exclusion compared to partial exclusion. In other words, the participant is so relieved to be experiencing some level of re-inclusion that neural conflict indexed by the N2 is lowered. These results suggest that N2 is activated when desired results and actual outcomes are in conflict, and that discrepancy causes amplification in the N2.

P3b amplitude, which is elicited when something in a situation requires our attention and reflects the allocation of attention to a stimulus or event (Polich, 2003), was larger (more positive) during exclusionary events in the second Cyberball block compared to the first Cyberball block, regardless of group. Therefore, during the second block, participants were still demonstrating increased attentional allocation to exclusionary events regardless of the level of exclusion experienced in the first block. These results correspond with previous research that has shown the P3b to be elicited during exclusionary event processing, with P3b amplitude relating to the participant's personal probability of being included (Weschke et al., 2013). Previous research has also shown P3b amplitude to be larger during the first half of the exclusion condition and then decrease during the second half (Kawamoto et al., 2013; Themanson et al., 2013; Themanson et al., 2015), implying that initial signs of exclusion elicit the strongest reactions, but once the participant becomes accustomed to the rejection the over activity subsides. However, our results show that P3b amplitude increased in the second block, suggesting that experiencing exclusion resulted in an increase in attention to subsequent social information, which is consistent with research on the Social Monitoring System (SMS; Pickett & Gardner, 2005). The SMS suggests that excluded individuals exhibit heightened sensitivity to social information following exclusion in an attempt to regain inclusion in their desired social groups.

Our results also found that P3b was greater in the PE_PI group (Partial Exclusion – Block 1, Partial Re-inclusion – Block 2) during exclusionary throws in the second block compared to any other manipulation group. In the other conditions, PE_CI (Partial Exclusion, Complete Re-inclusion), CE_PI (Complete Exclusion, Partial Re-inclusion), and CE_CI (Complete Exclusion, Complete Re-inclusion), P3b amplitude did not increase as much in the second block. Our N2 findings suggest that becoming partially re-included after being partially excluded results in greater conflict than any of the other conditions, as the participant's desire to be fully re-included has not been fulfilled. In relation to the P3b, it is possible that greater attentional allocation occurs during this situation in order to regulate and control the conflict as a means to understand the social situation and hopefully improve one's social standing. As mentioned before, humans are more likely to survive when they are a part of the group (Williams & Nida, 2011). Therefore, allocating attention to the situation, as indexed by the increased P3b, may be an attempt to determine differences in a social situation and improve subsequent interactions. This process is adaptive as recognizing one's exclusion, and realizing the reasons for the exclusion, can motivate individuals to alter their behavior in to order regain access into the group.

For the PE_CI (Partial Exclusion, Complete Re-inclusion) group, less P3b activation is evident in the second block, suggesting complete re-inclusion is able to fulfill the participant's desire for belonging and clarify the social conflict that was present. Therefore, this situation does not require as much attentional allocation from the participant to determine social standing. In the CE_PI (Complete Exclusion, Partial Re-inclusion), and CE_CI (Complete Exclusion, Complete Re-inclusion) conditions, less attentional allocation is needed in the second block because the participant has previously been completely excluded, so any level of re-inclusion is going to fulfill the participant's need to belong. With feelings of belonging, individuals experience less conflict; and therefore, there is less need for increased attention on how to attempt re-inclusion as one is satisfied with their level of re-inclusion.

Behavioral Measures

Results showed that being excluded negatively impacted individuals in terms of their needs fulfillment, which corresponds to previous research on the Need Threat model (Williams, 2007; Williams, 2009b). Further, participants reported more negative affect and less positive affect during the first block of Cyberball compared to the second, suggesting that affect was negatively influenced by exclusion and the experiencing exclusionary situations increases negative affect. This supports our hypothesis that exclusionary interactions were worse for individuals in terms of their needs for fulfillment compared to inclusionary interactions, which was supported by previous research that varying degrees of social involvement in interactions are associated with both different patterns of neural activation and greater exclusion-related social distress compared to partial exclusion, Additionally, becoming re-included has the ability to decrease social distress by reducing negative affect. Results also suggested that participants who were first completely excluded, but then partially re-included had a significant increase in the fulfillment for the need for control, a subscale of the NTS. The need for control is threatened during exclusion becomes one lacks the ability to make an impact on their surroundings (Williams, 2007). This occurs because the excluded individual has no power in the exclusionary situation, as one cannot force a social interaction (Williams, 2007). This lack of control may influence the individual to engage in pro-social behavior as a means to regain approval from the source of the exclusion. These results suggest that regaining social approval from the source of exclusion, as evidence by the re-inclusion of the participant, resulted in a increase in one's self-reported sense of control because the participants were able to regain access into the group. This suggests that even the slightest bit of re-inclusion after experiencing exclusion is able to reduce the emotional distress that results from exclusion.

Limitations and Future Directions

The demographic composition of this study could have been a possible limitation, as this study did not look at differences between genders. Of the 48 participants in the analyses, 18 were male and 30 were female. Research has shown that females are excluded more often than males and are more sensitive to social exclusion than males (Benenson et al., 2013). Additionally, other research has shown that the ACC is more activated during same-sex exclusion in comparison to exclusion by the opposite sex (Bolling et al., 2012). Therefore, analyzing the differences between genders for this study may have provided interesting results. A possible reason for female heavy participation is the enrollment demographics for Illinois Wesleyan University, as females make up 56% of the female body. Additionally, our participant pool came out of students in General Psychology, which is generally a female-dominated course. Another possible limitation was the small sample size. Although we did see significant effects with the current sample size, a larger sample size may have enabled a more powerful analysis of the current relationships, and thus resulted in more significant effects. We also experienced a few equipment malfunctions that caused us to cancel testing for a few weeks, thus decreasing the amount of participants we could test during the semester. Another limitation was our very young population sample, aging between 18-22. Research has shown that older individuals experience less need threat as a result of exclusion (Hawkley, Williams, & Cacioppo, 2011). Additionally, cognitive functioning changes with age; therefore, this study's results might have been different if we were to include older individuals in this study. Our sample size was young due to the fact that our participant pool consisted of students in the General Psychology courses.

Additional limitations may have resulted from a lack of considering racial differences among participants. Social exclusion is not limited by race, sexuality, or cultural identity; therefore, also studying the effects, relationships, and interactions of race could provide interesting results. Research has shown that individuals experience more social pain when they are excluded by their in-group (a group with which individuals share similar characteristics, such as race, gender and ethnicity) compared to out-groups (a group with which individuals do not share similar characteristics, such as race, gender and ethnicity) (Sacco et al., 2014). Additionally, within intrapersonal relationships, racism and sexism are considered forms of social exclusion, as in these instances people with specific characteristics are discriminated against and excluded from society (Williams, 2009a). Although this would be an interesting topic to pursue, our participant pool does not have the necessary racial or cultural diversity to report any significant findings due to low percentages of diversity at the University as a whole. 71% of the student body at Illinois Wesleyan University identifies as Caucasian, with the next highest percentage being International at 8%. Therefore, we would not be able to collect sufficient enough data to consider the effects on race. Future studies at larger or more diverse universities should consider taking race into account when conducting a similar study.

Future studies may also want to consider the effects on other marginalized groups, such as LBGTQ individuals and students with physical handicaps, as these are groups that have not been studied before in social exclusion. This study could also consider how the attractiveness and age of the sources of exclusion influence participant's neural and behavioral responses, by inserting images of the computer programmed "participants" onto the screen. Additionally, it would be interesting to see how changing the names of the participants would affect neural and behavioral responses. In our study, the computer programmed Cyberball "participants" were named "Jen" and "Ann" for female participants, and "Mike" and "Eric" for male participants. It would be interesting to see if using more culturally or ethnically diverse names would produce different results. With the prominent Caucasian population at Illinois Wesleyan, it would be quite easy to specifically study Caucasian biases that result from exclusion by another race. Additionally, this study had poor spatial resolution; therefore, future studies may want to consider doing both ERP and fMRI studies to broaden neural findings.

Implications

This study provided additional information on the effects of ostracism on individuals. Specifically, it provided insight into how experiencing re-inclusion after exclusionary events can reduce neural and social distress; thereby, enabling a better understanding of the effects of re-inclusion, and providing a basis for the levels of re-inclusion necessary to alleviate some of the social pain caused by varying levels of exclusion. Exclusionary studies are very important because evidence has shown that being excluded elicits the same neural responses as being in physical pain. Although we have seen exclusion throughout generations and demonstrated in many cultures, the world has also seen the negative effects of marginalizing individuals. On a large scale, exclusionary studies focusing on re-inclusion may benefit the global society, by providing previously exclusionary government systems, such as Apartheid South Africa, how to properly with information on how to re-include previously marginalized individuals, governments may be able to reduce social distress and mitigate possible social upheavals within their populations.

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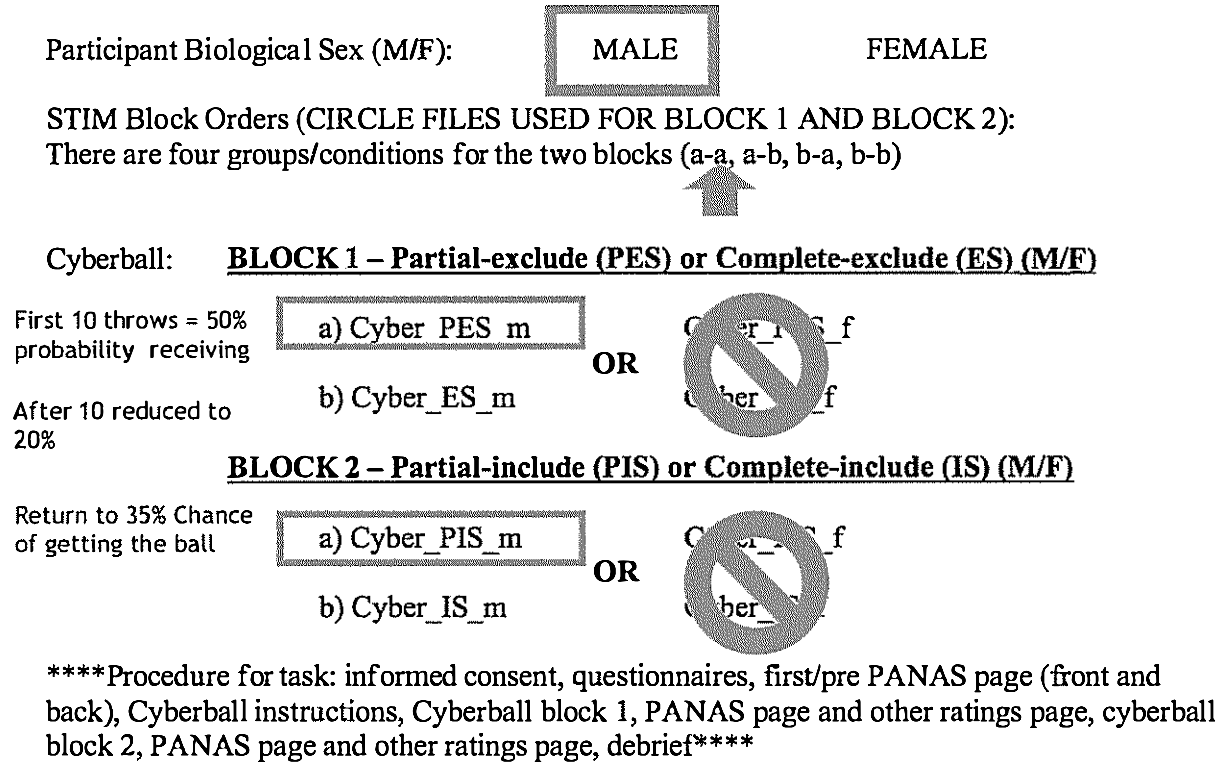


Participant Biological Sex (M/F): MALE FEMALE

STIM Block Orders (CIRCLE FILES USED FOR BLOCK 1 AND BLOCK 2):
There are four groups/conditions for the two blocks (a-a, a-b, b-a, b-b)

Cyberball: **BLOCK 1 – Partial-exclude (PES) or Complete-exclude (ES) (M/F)**

First 10 throws = 50% probability receiving

After 10 reduced to 20%

a) Cyber_PES_m OR

b) Cyber_ES_m

BLOCK 2 – Partial-include (PIS) or Complete-include (IS) (M/F)

Return to 35% Chance of getting the ball

a) Cyber_PIS_m OR

b) Cyber_IS_m

****Procedure for task: informed consent, questionnaires, first/pre PANAS page (front and back), Cyberball instructions, Cyberball block 1, PANAS page and other ratings page, cyberball block 2, PANAS page and other ratings page, debrief****

Figure 1. Example stimulus sheet for Participant 001. In block 1, participant is partially excluded. In block 2, participant is partially re-included.

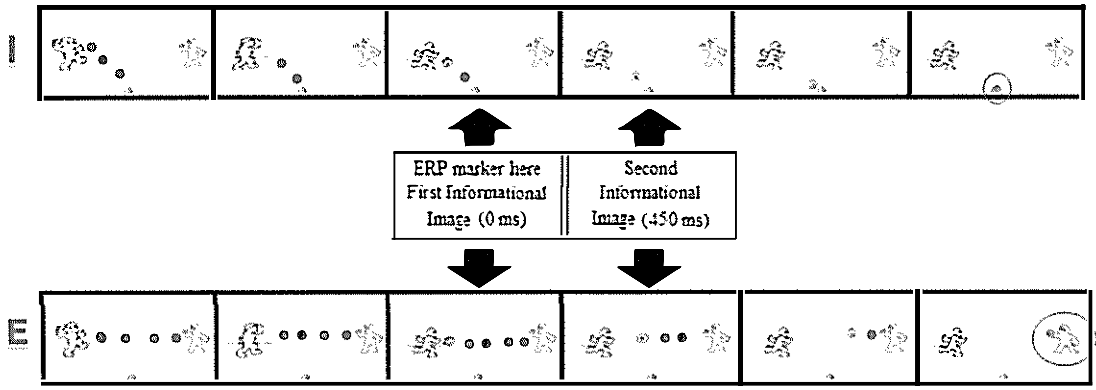


Figure 2. Visual example of inclusionary and exclusionary throws during Cyberball game. ERP markers were inserted at the first informational frame providing information about the recipient of each throw.

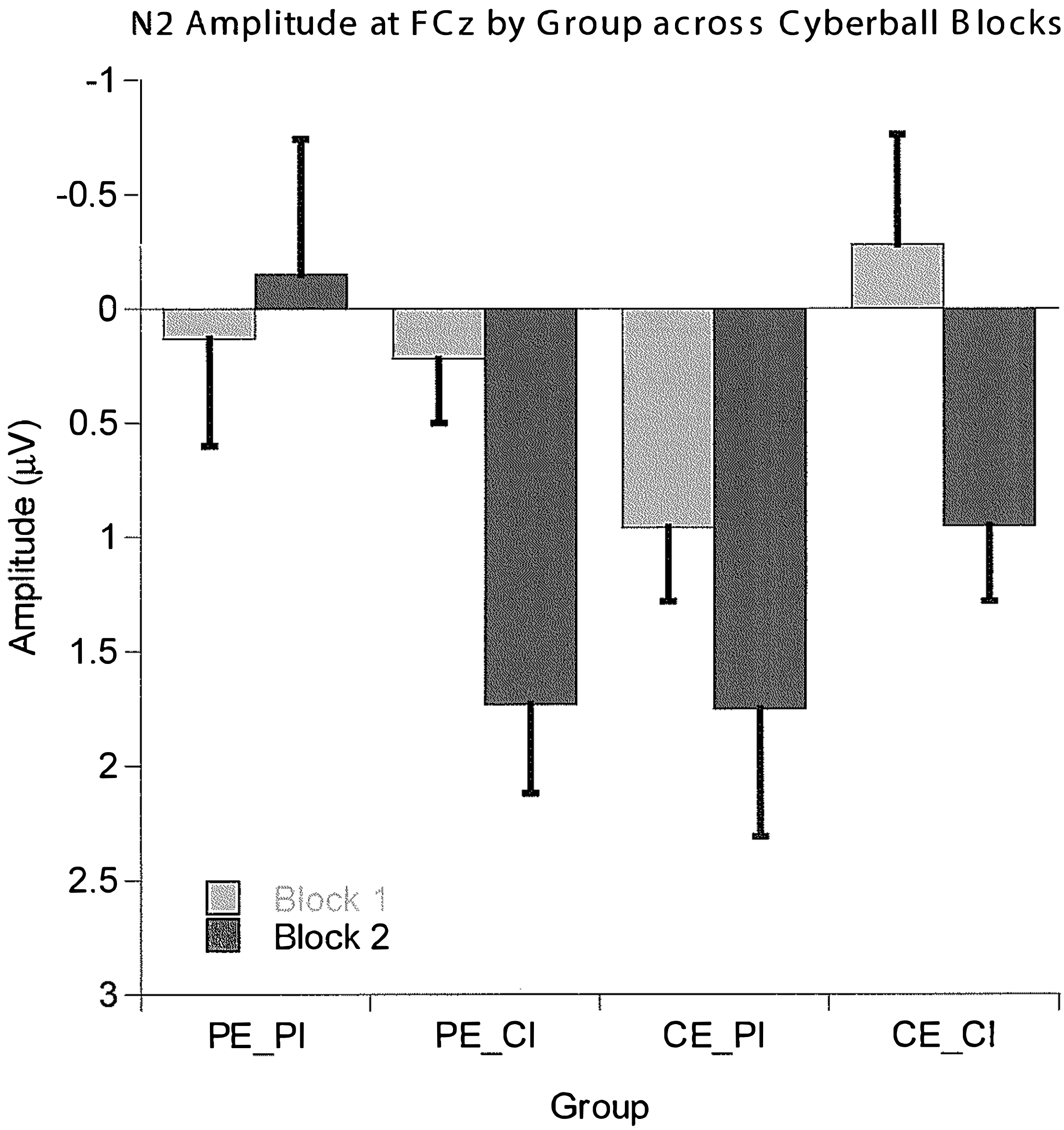


Figure 3. Grand-averaged stimulus locked ERP bar graph for exclusionary throws at electrode site FCz (N2 component). PE_PI Group is partial exclusion, partial inclusion. PE_CI Group is partial exclusion, complete re-inclusion; CE_PI Group is complete exclusion, partial re-inclusion. CE_CI Group is complete exclusion, complete re-inclusion.

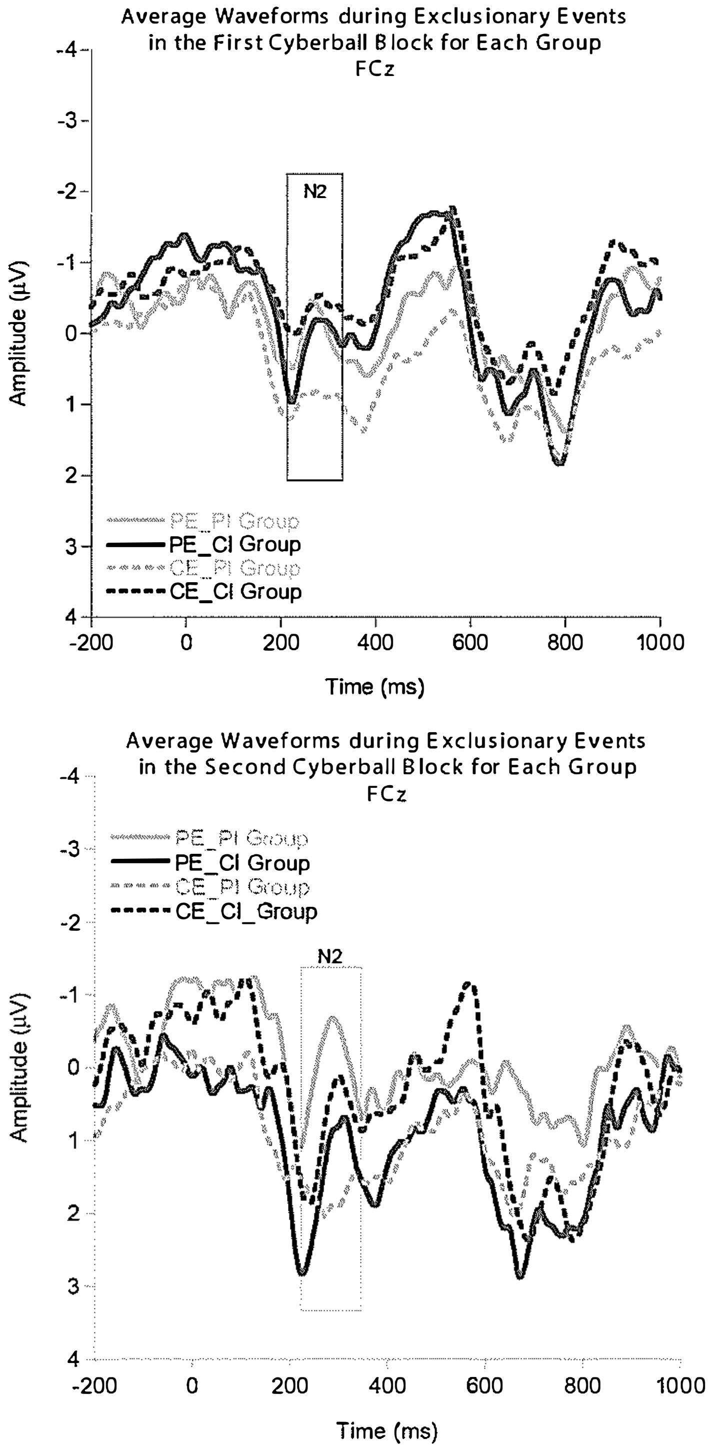


Figure 4. Grand-averaged stimulus locked ERP waveforms for exclusionary throws at electrode site FCz (N2 component). Block 1 is above and block 2 is below. PE_PI Group is partial exclusion, partial inclusion. PE_CI Group is partial exclusion, complete re-inclusion; CE_PI Group is complete exclusion, partial re-inclusion. CE_CI Group is complete exclusion, complete re-inclusion.

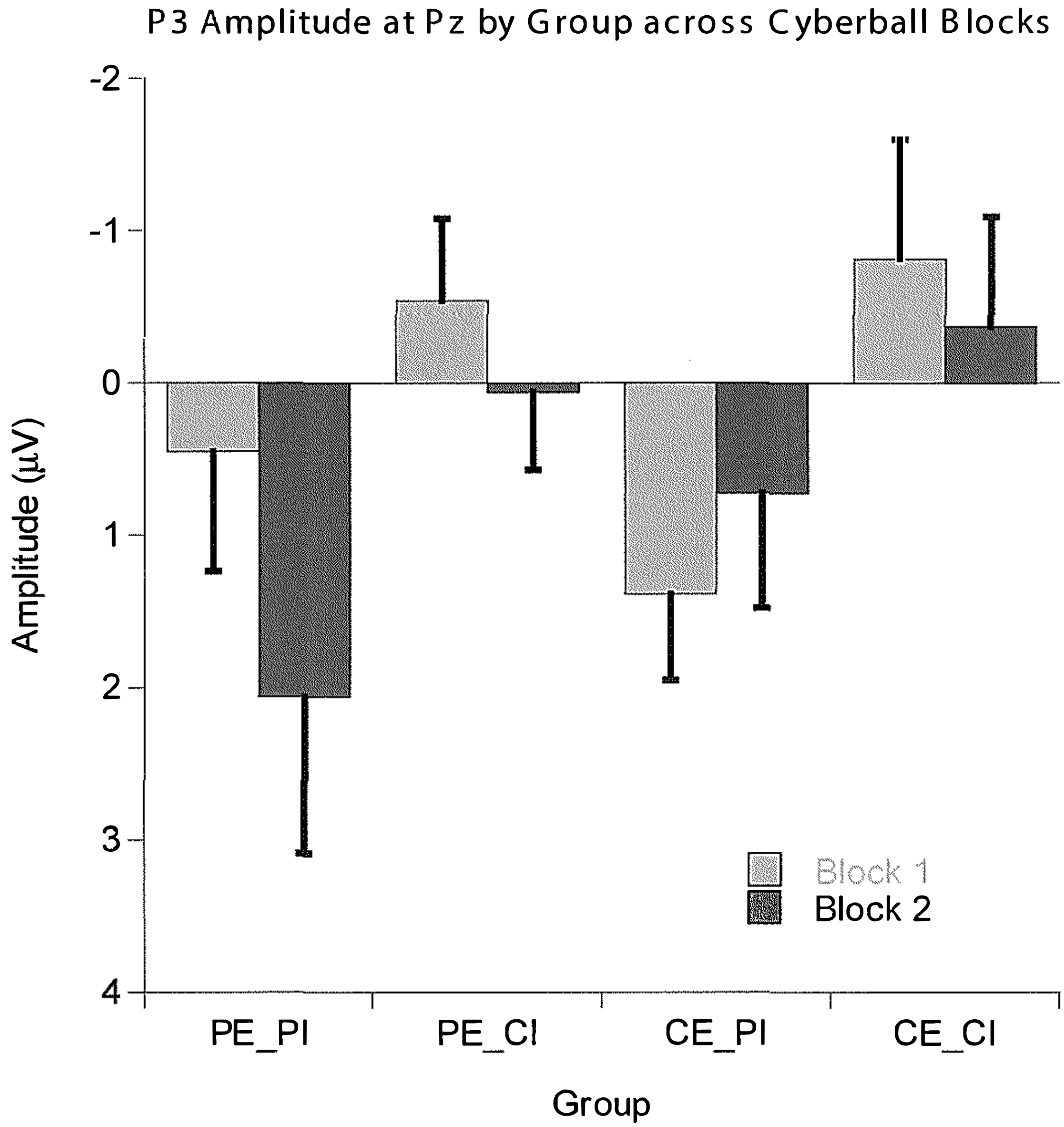
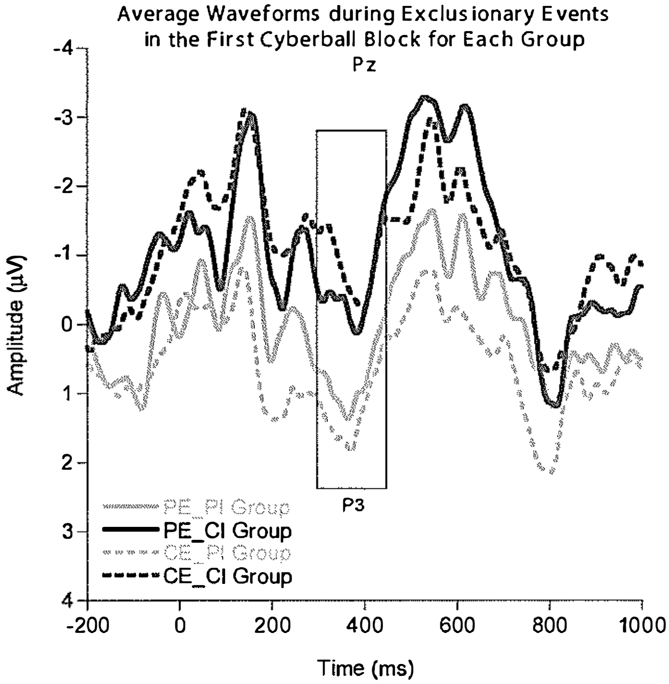


Figure 5. Grand-averaged stimulus locked ERP bar graph for exclusionary throws at electrode site Pz (P3b component) for block 1 (gray) and block 2 (green). PE_PI Group is partial exclusion, partial inclusion. PE_CI Group is partial exclusion, complete re-inclusion; CE_PI Group is complete exclusion, partial re-inclusion. CE_CI Group is complete exclusion, complete re-inclusion.



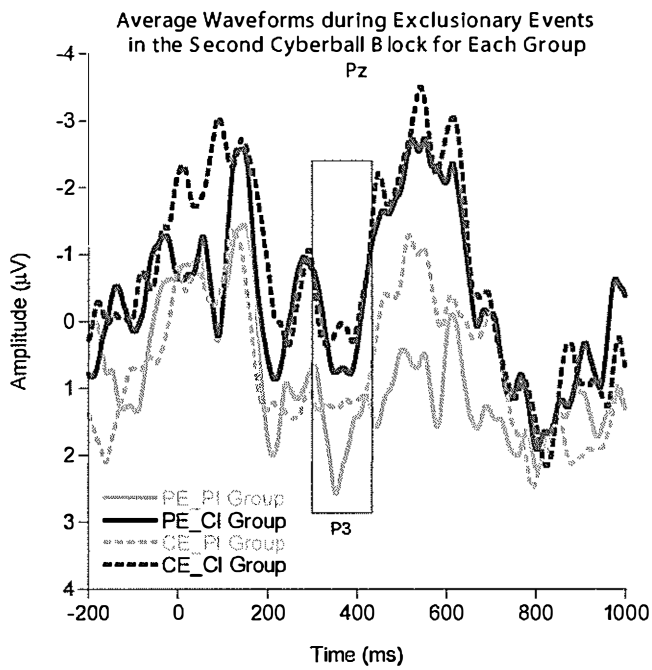


Figure 6. Grand-averaged stimulus locked ERP waveforms for exclusionary throws at electrode site Pz (P3b component). Block 1 is above and block 2 is below. PE_PI Group is partial exclusion, partial inclusion. PE_CI Group is partial exclusion, complete re-inclusion; CE_PI Group is complete exclusion, partial re-inclusion. CE_CI Group is complete exclusion, complete re-inclusion.