2014

Frontal Lobe Theta Activity in Socially Ostracized Individuals: Understanding Social Ostracism through EEG

Victoria Whitaker
Illinois Wesleyan University

Frontal Lobe Theta Activity in Socially Ostracized Individuals:

Understanding Social Ostracism through EEG

Victoria Whitaker

Illinois Wesleyan University

Abstract

The present study used a chat room paradigm to examine the effects of social ostracism on theta EEG activity in the frontal lobe. Participants were placed in an online chat room with two other individuals whose chat room profiles indicated they were both the opposite gender of the participant and attending other universities in central Illinois. Unknown to participants, these individuals were actually confederates in the study, and the pictures used on these profiles had previously been rated as either attractive or unattractive by college students. This experiment consisted of three primary phases. In the first phase, confederates actively included the participant in the chat room conversation. In the second phase, the participant was completely ignored (social ostracism manipulation). Confederates re-included the participant in the last phase of the chat room conversation. The purpose of the present study was to investigate variables that may influence the experience of social ostracism, such as gender and attractiveness of the ostracizing students. Results indicated that the ostracism manipulation was successful, with participants reporting significantly lowered enjoyment, interest, participation, and overall engagement during exclusion, while EEG data showed a non-significant trend for lowered theta power during exclusion that did not reach significance. Attractiveness of ostracizing peers played a role in the chat room experience, with participants reporting greater engagement with unattractive peers and male participants showing a larger difference in engagement between attractiveness conditions. In addition, there was a significant interaction between phase and attractiveness condition in theta EEG activity. No gender main effects were documented in self-report or EEG data. Future research is needed to continue to examine the roles that gender and attractiveness play in social ostracism.

Keywords: social ostracism, theta, frontal lobe, attractiveness

Frontal Lobe Theta Activity in Socially Ostracized Individuals: Understanding Social Ostracism through EEG

Social ostracism is exclusion that leads individuals to feel left out, snubbed, or rejected in some way (DeWall & Richman, 2011). Although some degree of ostracism is part of life for most humans, it is nonetheless a highly negative experience (Bastian & Haslam, 2010; Boyes & French, 2009; Eisenberger, Lieberman, and Williams, 2003; Kawamoto et al., 2012). For example, social ostracism can result in lowered self-esteem (Williams & Jarvis, 2006), heightened levels of anxiety and depression (Campbell, Spears, Slee, Butler, & Kift, 2012), and lowered satisfaction with life (Schnieder, Hitlan, & Radhakrishnan, 2000). In an increasingly digital world, use of social media provides a greater number of opportunities for people to be ostracized. Not only can individuals be ostracized at school or in the workplace, but this ostracism can persist at all hours of the day via social media like Facebook and Twitter, allowing individuals to experience social rejection at any time. In an internet and social media-obsessed culture, nearly every teen and many adults use and keep one or more online profiles updated in order to connect with friends, with 83% of young adult internet users ages 18 – 29 maintaining social networking profiles (Duggan & Brenner, 2013). Young women are particularly likely to have online profiles (i.e. Instagram, Twitter, Facebook, etc.) compared to men and older adults, and are also likely to have more than one (Duggan & Brenner, 2013). Most importantly, the experience of cyberbullying (ostracism that occurs via online social networking sites) may have more adverse effects than traditional bullying (Campbell, Spears, Slee, Butler, & Kift, 2012; Kowalski & Limber, 2013).

Because of the expanding opportunities to be socially ostracized in today's society, it is vital to understand the social, emotional, behavioral, and neural effects of social ostracism in

order to reach a more comprehensive understanding of these effects. Additionally, it is important to know the factors that mediate this experience. The current study investigates whether factors such as gender and attractiveness alter the way in which social ostracism is experienced on both a behavioral and neural level. In order to fully comprehend ostracism, it is important to understand a) the negative effects of social ostracism, b) the biological mechanisms involved in processing ostracism, including brain structures as well as theta EEG activity, and c) the factors that can alter the ostracism experience.

Negative Effects of Social Ostracism

Social ostracism puts individuals at increased risk for both negative mental and physical health outcomes (Bastian & Haslam, 2010; Bastian, Jetten, Chen, Radke, Harding, & Fasoli, 2013; Schnieder, Hitlan, & Radhakrishnan, 2000; Wolke, Copeland, Angold, and Costello, 2013). Individuals who are bullied show increased risk for health problems later in life (Wolke, Copeland, Angold, and Costello, 2013) and are at a higher risk for suicide (Campbell, Spears, Slee, Butler, & Kift, 2012). It is natural for humans to feel soothed in the presence of others with whom they are close and to feel distressed when left out by these same individuals (Eisenberger, Lieberman, & Williams, 2003, p. 290). Indeed, participants who experience greater amounts of ostracism report lowered psychological well-being, including lowered self-esteem (Boyes & French, 2009; Williams & Jarvis, 2006) as well as lowered levels of life satisfaction and increased incidences of post-traumatic stress disorder (Schnieder, Hitlan, & Radhakrishnan, 2000). Ostracized individuals who are cyberbullied tend to show higher levels of anxiety and depression compared to those who are not bullied (Campbell, Spears, Slee, Butler, & Kift, 2012). In response to social ostracism, individuals show increases in self-defeating behaviors, including procrastination, poor time management, foolish risk-taking (i.e., heavy alcohol or drug use), and

a belief that life is meaningless (Renn, Allen, and Huning, 2013; Twenge, Catanese, and Baumeister, 2003). These effects in turn can result in a deterioration of social relationships and interactions with others.

Ostracized individuals face poor interpersonal outcomes as a result of social ostracism (Bastian & Haslam, 2010; Bastian, Jetten, Chen, Radke, Harding, & Fasoli, 2013; Schnieder, Hitlan, & Radhakrishnan, 2000; Wolke, Copeland, Angold, and Costello, 2013). A tendency to view others, as well as oneself, as less human after one has been ostracized may eventually lead to a disconnect that further distances a socially ostracized individual from others (Bastian & Haslam, 2010; Bastian, Jetten, Chen, Radke, Harding, & Fasoli, 2013). Ostracized people "may experience themselves as located outside the boundary of humanity" (Bastian & Haslam, 2010, p. 112). This negative view of oneself, others, and humanity as a whole has other negative consequences, some of which can persist long-term if ostracism is experienced frequently. A negative view of oneself and disconnect with peers are among the factors that lead to social pain.

Biological Pain Mechanisms

Although the resulting behaviors and health effects of social ostracism have been well-documented, it is important to understand the underlying brain structures that contribute to social pain in order to fully understand different aspects of the ostracism experience. Negative effects of social ostracism, such as loss of self-esteem, are linked to changes in frontal lobe activity (Kawamoto, Onoda, Nakashima, Nittono, Yamaguchi, & Ura, 2012). The anterior cingulate cortex (ACC) and prefrontal cortex (PFC) each play a central role in processing social pain. More specifically, the dorsal ACC (dACC) and right ventrolateral prefrontal cortex (rVLPFC) play the most significant roles in processing social ostracism.

The dorsal ACC (dACC) plays a role in the affective, or emotional, component of pain experiences (Eisenberger, 2011; Hadland, Rushworth, Gaffan, & Passingham, 2003; MacDonald & Leary, 2005; Rainville, 2002; Rainville, Duncan, Price, Carrier, & Bushnell, 1997). The dACC recognizes and determines the severity of social pain, working to determine the degree of negativity associated with an ostracism experience. Human fMRI studies confirm the ACC is activated in response to and is responsible for the detection of social exclusion (Eisenberger, Lieberman, & Williams, 2003; Kawamoto, Onoda, Nakashima, Nittono, Yamaguchi, & Ura, 2012). The dACC is activated significantly more during exclusion compared to inclusion conditions in experimental studies, providing support for the role the ACC plays in emotional and social cognition (Kawamoto, Onoda, Nakashima, Nittono, Yamaguchi, & Ura, 2012). In animal studies, cingulate lesions in the brains of macaques significantly decrease vocalizations and interactions with other macaques, providing evidence that the cingulate plays a role in social-emotional interactions of other species in addition to humans (Hadland, Rushworth, Gaffan, and Passingham, 2003).

While the dACC is involved in the affective component of social pain the PFC is involved in the regulation of both social and physical pain. (Kawamoto et al., 2012; Lopez-Sola, Pujol, Hernandez-Ribas, Harrison, Ortiz, Soriano-Mas, Deus, Menchon, Vellejo, and Cardoner, 2010; Rainville, 2002). The area of the right lateral PFC responsible for processing pain is the rVLPFC (Kawamoto et al., 2012). The rVLPFC is activated during social exclusion, and increasing activity in this brain area is associated with decreases in self-reported social pain (Kawamoto et al., 2012). Similarly, in an experiment focused on physical pain, participants were exposed to painful pressure applied to a thumbnail on their right hand (Lopez-Sola et al, 2010). Unpleasantness ratings of the stimulus were negatively correlated with activation of the anterior

portion of the PFC; the more unpleasant the stimulus was rated by the participant, the less activation the PFC showed (Lopez-Sola et al, 2010). In order to decrease unpleasantness, PFC activation needed to increase. Thus, the socioemotional component of pain (pain unpleasantness) is reflected in PFC activity. Because the right lateral PFC modulates behavior in response to aversive stimuli, this finding serves as evidence for the right PFC's role in down-regulation of aversive emotions, including social pain.

In summary, the dACC is responsible for the affective component of pain – recognizing and responding emotionally to social exclusion. Meanwhile, the rVLPFC works to reduce this pain – in the case of this study, the pain associated with exclusion. Activation of these areas indicates that actions need to occur to reduce the pain experience. Through the interaction of these brain areas, individuals are able to respond to social ostracism.

Theta

Although biological work has revealed the frontal brain structures involved in processing social ostracism, little research has been conducted involving frontal lobe theta, a type of slow wave band with a frequency of four to eight hertz (Putman, van Peer, Maimari, & van der Werff, 2010) that may be analyzed in electroencephalogram (EEG) recordings in relation to social ostracism experiences. Theta waves are able to reflect emotional responses that are signaled by changes in the PFC and ACC, along with other frontal lobe areas, and changes in theta power indicate changes in emotional state (Aftanas & Golocheikine, 2001; Davidson, 2004). The intensity of a blissful experience like meditation is positively correlated with theta power (Aftanas and Golocheikine, 2001). On the other hand, decreases in theta power have been documented in participants who are unable to reach a meditative state and experience negative emotions such as frustration (Aftanas and Golocheikine, 2001). Due to the finding that theta

power decreases when one is unable to achieve a blissful experience and experience negative emotions instead, it is feasible that theta power is also associated with social ostracism. A study investigating theta's role in emotion regulation also provides evidence for a relationship between theta oscillations and emotion (Ertl, Hildebrandt, Ourina, Leicht, & Mulert, 2013). When study participants are instructed to either increase or decrease the intensity of their negative affect (defined as negative emotions) in response to a negative picture (for instance, a car accident), theta oscillations in the frontal lobe increase (Ertl et al., 2013). In contrast, conditions in which participants are instructed to maintain their present affect do not show increases in frontal lobe theta EEG (Ertl et al., 2013). These results provide support for theta's role in the experience and regulation of both positive and negative emotions, making it a potential moderator of ostracism.

Although theta has not been extensively researched specifically in relation to social ostracism, theta power was tested as a dependent variable in a past study done at Illinois Wesleyan University (Williams, Morozink, Sanderson, & French). Unpublished results from the prior study done at this university showed a significant decrease in frontal theta power as a result of being socially ostracized by peers, similar to a study in which participants who experienced negative emotions showed a decrease in theta power (Aftanas & Golocheikine, 2001). These results are slightly confusing given evidence from separate studies that show that increasing the intensity of negative emotion increases theta power (Ertl et al., 2013). However, the expectations for this study fit with previous findings that negative experiences might be negatively correlated with theta power while positive experiences are correlated positively with theta power (Aftanas & Golocheikine, 2001).

Factors Influencing Ostracism: Gender and Attractiveness

Theta provides a way to measure the varying impacts of different factors contributing to

ostracism, such as the attractiveness and gender of ostracizing peers. Past research indicates that these factors alter social interactions (Bolling, Pelphrey, & Vander Wyk, 2012; Reis, Nezlek, & Wheeler, 1980; Reis, Wheeler, Spiegel, Kernis, Nezlek, & Perri, 1982). Because attractiveness and gender both alter the dynamics of social interactions, it is feasible these factors also mediate the perceived negativity of social ostracism.

Children learn early in life that physically attractive people are expected to also have socially desirable traits (Adams, Hicken, & Salehi, 1987; Aronson, Wilson, & Akert, 2010; Dion, Berschied, & Walster, 1972). Attractive individuals are assumed to be sociable, sensitive, likeable, empathetic, honest, and generous (Aronson, Wilson, and Akert, 2010). Consequently, people anticipate positive social interactions with others who are deemed "attractive." This stereotype has been shown to have an effect across cultures (Aronson, Wilson, and Akert, 2010). Due to the pervasiveness of this stereotype, it is possible that being ostracized socially by an attractive individual would come as a surprise to many people. Humans tend to expect attractive individuals to be kind, which could include being inclusive of others, no matter the culture, because we believe physically attractive people to be good people (Dion, Berschied, & Walster, 1972). When an individual's assumptions are proven to be incorrect, the ostracism experience is likely to be more negative because it is unexpected.

Indeed, attractiveness is positively correlated with quality of social interactions in self-reported studies of social interaction (Reis, Nezlek, & Wheeler, 1980; Reis, Wheeler, Spiegel, Kernis, Nezlek, and Perri, 1982), providing evidence that social expectations for attractive individuals might play a role in social ostracism. Participants in these studies kept journal-style records of social interactions over a one to two week period. Journal entries were then analyzed for constructs such as satisfaction, intimacy, and length of interaction. Satisfaction ratings were

significantly correlated with physical attractiveness, such that more attractive individuals reported more satisfaction in their interactions with others (Reis, Nezlek, & Wheeler, 1980). Attractiveness is also positively correlated with quantity and quality of interactions reported (Reis, Wheeler, Spiegel, Kernis, Nezlek, & Perri, 1982).

Humans might be aware of the tendency for attractive individuals to have more satisfactory interactions with others (Reis, Nezlek, & Wheeler, 1980), and this social stereotype could potentially impact how people respond to social ostracism by attractive peers. For instance, people might expect a reciprocal interaction in the sense that interacting with an attractive individual is satisfying to both parties involved. Therefore, if one has an unsatisfactory interaction -- for instance, experiencing ostracism -- with an attractive peer, the resulting feelings associated with ostracism might be more negative than if one was ostracized by a less attractive peer, with whom they might have anticipated a less satisfactory interaction in the first place. The current study aims to explore this possibility.

Attractiveness might interact with gender to change the ways social interactions, including ostracism, occur (Bolling, Pelphrey, & Vander Wyk, 2012; Reis, Nezlek, and Wheeler, 1980; Reis et al., 1982). Exclusion studies support the hypothesis that males and females interact in different ways (Benenson et al., 2011; Bolling, Pelphrey, & Vander Wyk, 2012). During exclusion by same-sex peers using a Cyberball paradigm, participants' brains react differently compared with exclusion by opposite-sex peers, as measured by fMRI. Specifically, ventral ACC activation appears to increase during exclusion by those of the same gender, but not during exclusion by opposite-gender peers, signifying a more negative reaction to exclusion to those sharing one's gender. In contrast, activation in the rVLPFC is negatively correlated with distress (as measured by self-reports) in exclusion by those of the opposite gender, but is not significantly

correlated with distress during same-gender exclusion (Bolling, Pelphrey, & Vander Wyk, 2012). Additionally, females are more likely than males to exclude others when they are under threat of social ostracism (Benenson, Markovits, Thompson, & Wrangham, 2011).

Interestingly, males in one study interacted less with females and reported lower quality of interactions due to fear of rejection (Reis, Wheeler, Spiegel, Kernis, Nezlek, & Perri, 1982). Perhaps this is due to the knowledge that females are more apt to ostracize others (Benenson et al., 2011). However, exclusion may be tied more strongly to interactions with same-sex peers. In a study of social interactions using self-reports, physical attractiveness in males was found to be positively correlated with quality social interactions with females, but negatively correlated with quality social interactions with males (Reis, Nezlek, and Wheeler, 1980). This physical attractiveness leads to quality interactions with opposite-sex peers, while interactions with same-sex peers might be neutral or negative.

The Current Study

The current study seeks to expand the existing ostracism literature by 1) putting participants in a chat room environment in which they are excluded, 2) clarifying whether participants respond more strongly to ostracism by attractive or unattractive opposite-gender peers and 3) analyzing theta power as a measure of the social ostracism experience. Our use of a chat room paradigm is true to the current social climate, and can add important knowledge by providing evidence for whether past results can generalize across different ostracism situations. In addition, gender and attractiveness have not been investigated often in connection with social ostracism, so this study seeks to explore these variables. Lastly, although results hint at a relationship between theta and negative emotional experiences, theta has not been extensively studied in relation to social ostracism.

In comparison with phases in which they are included in the chat room conversation, the researchers predicted that participants would show reduced engagement (measured by self-reported interest, participation, and enjoyment) as well as reduced theta activity in three tested frontal lobe brain regions (F_3, F_4, F_z) during the exclusion phase of the experiment. The frontal lobe regions analyzed by this study were chosen due to their location -- part of the PFC and responsive to the dACC -- as well as based on previous studies that show these areas are responsive to emotional stimuli (Asada, Fukada, Tsunoda, Yamaguchi, & Tonoike, 1999; Kawamoto et al., 2012). Researchers also predicted that those who believe they are being ostracized by more attractive peers will report feeling a greater degree of ostracism in comparison to those who are ostracized by less attractive peers, in addition to this group showing reduced theta power. Because exclusion studies have shown that males and females respond differently to ostracism (Reis et al., 1982), it was hypothesized that males and females would show differences in level of perceived ostracism and self-report measures as well as theta power.

Method

Participants

Fifty-six Illinois Wesleyan University undergraduate students, aged 18-21, were recruited for this study. Data from some participants was screened out due to excessive noise on EEG recordings. After the screening process, data from forty-four participants (30 females and 14 males) was analyzed. Most participants came from General Psychology sections and received course credit for their participation; a few participants came from a Lifespan Development class offered by the Psychology department and received extra credit for their participation. Most participants were white (N = 32), followed by Asian (N = 5), and Latino/Latina (N = 3). Four participants chose to not identify their race.

Attractiveness Manipulation

In the current study, participants entered an online chat room with two other individuals they were led to believe were fellow students at other Illinois universities. In reality, these "students" were confederates recruited for the study. Participants were randomly assigned to chat with attractive or unattractive peers. The pictures used for the confederates were previously pilot tested at Illinois Wesleyan University to ensure that attractiveness ratings differed between pictures such that attractive pictures were indeed rated higher on an attractiveness scale. For example, on a scale ranging from 1 (not attractive at all) to 9 (very attractive), it was expected that unattractive pictures be rated below 5, and attractive pictures rated above 5. The current study used the two pictures for each gender that were rated highest and lowest in attractiveness in the previous study. In order to assure similarity across conditions, pictures focused in on the face and had similar photo backgrounds. See Appendix 1 for sample confederate profile pictures. Data from 18 participants was analyzed for the attractive condition (5 male, 13 female) and data from 26 participants was analyzed for the unattractive condition (9 male, 17 female) after the screening of EEG files. Similar to the participant's profile, each confederate profile in the chat room was given a profile that included a picture, and this picture appeared to the side of each comment typed in the chat room. In addition, these pictures could be viewed on a larger scale in a "chat room members" tab. The presence of these photos allowed for an attractiveness manipulation in which some participants interacted with chat room members deemed "attractive," while other participants interacted with chat room members considered less attractive. Participants were randomly assigned to one of these two conditions, and chatted with two individuals who were opposite of the participant's gender. Names used in the chat room by the study's confederates remained the same across attractiveness conditions. When participants

were male (and thus chatting with female confederates) the female names used were Jessica and Gia. Female participants entered the chat room with 2 males named Kyle and Billy. In reality, these other "students" were confederates who were part of the research team. However, the pictures used for the confederate profiles were chosen from the internet as part of a past study, and were not actually pictures of the research confederates. Following the introduction to the experiment, the EEG cap was fitted and the participant was seated in front of the computer in the EEG lab.

Procedure

Participants were invited to engage in a study of "brain activity in a chat room environment." Upon entering the EEG lab with a researcher, participants were asked to read and sign an informed consent form. After obtaining informed consent, the researcher helped the participant upload their photo to an online chat room profile. Some participants opted to take a picture in the EEG lab, while others chose to upload a pre-existing picture. These online profiles included items such as name, age, gender, major, and other interests. See Appendix 1 for sample confederate profiles. Following the completion of these steps, the experimenter instructed the participant about the study. Participants were led to believe that they were entering an online chat room with two students from other universities for a study on communication styles -- specifically, the University of Illinois and Illinois State University. These two students were of the opposite gender as the participant. After participants were instructed about the study and were taught how the chat room worked, researchers applied an EEG cap to the participant's head.

To measure frontal lobe theta EEG power (amplitude), Neuroscan Quik-caps with 64 electrode sites were used. The current study was interested in 3 recording sites: F_3, F_4, and F_z, all

located in the frontal lobe (one in the right hemisphere, another in the middle, and the third located in the left hemisphere). To fit the EEG cap to each participant's head, researchers followed instructions found in the Neuroelectric Measurement Training Manual provided to the researchers by the Psychology department. Once the cap was placed properly on the participant, the six hanging, or drop, electrodes could be placed in order to pick up on eye blinks that were later edited out of the EEG data. Two drop electrodes were placed behind the participant's ears (one behind the right, one behind the left) as reference electrodes. Three electrodes were placed around the participant's left eye: directly above and below the center of the eye, as well as to the side. Another electrode was placed to the side of the right eye. The electrodes placed to the sides of the eyes measured horizontal eye movement, and the electrodes placed on top and bottom of the left eye were used to measure eye blinks. Electrodes were filled with gel as prescribed by the EEG training manual. After each sensor was filled, mesh elastic gauze was fitted over the cap to allow for an optimum connection and the cap's chin strap was fitted by the participant.

Once the cap was fitted, a researcher made a mock phone call, presumably to a researcher at another university, to reinforce the cover story that the participants would be entering a chat room with students from other schools. The participant was reminded to remain still, so as to not interfere with the EEG signal. Following these steps the researcher exited the lab and began the study as the administrator of the chat room.

The current study employed the same chat room procedure as a previous study done at the university in 2011. To begin the study, the administrator instructed the chat room members, "Please take the next eight minutes to introduce yourselves to one another." Common topics in this phase included the university attended by the student, majors, year in school, and background information such as hometown.

Following this introductory phase, three experimental eight-minute phases were conducted. The three topics used for these phases were television (TV), restaurants, and hobbies. These topics were randomly counterbalanced across experimental phases. A researcher acting as the chat room's administrator instructed students when the time expired in each phase, and informed students of their next topic. In the first phase, participants were actively included in the conversation. For instance, if the first topic was TV, the confederates followed a loose script that included the participant – for example, discussing an episode of *Breaking Bad* or *Criminal Minds* that was mutually enjoyed by both the participant and confederates. When the phase reached the eight minute mark, the administrator instructed the members of the chat room: "Ok, time is up. Please take a moment to fill out the first page of your questionnaire." This questionnaire was composed of three items asking about enjoyment, participation, and interest in the receding chat room conversation. Once the questionnaire was completed by the participant, the administrator indicated the next topic of conversation.

The second phase consisted of the confederates excluding the participant from the chat room conversation. Participants were randomly assigned to discuss TV, hobbies, or restaurants for the exclusion phase. After the topic for the second phase was introduced, confederates did not pay any attention to the participant – even if the participant attempted to communicate with the confederates, these attempts were ignored. This was accomplished through the use of a set script from which the confederates did not deviate (see Appendix 2 for sample exclusion scripts). The confederates were given scripts that purposefully discussed obscure topics in the hope that participants would be unfamiliar with the topic and would not guess the true nature of the experiment. When the topic was TV, confederates discussed a show called "The Increasingly Poor Decisions of Todd Margaret." The hobbies script discussed origami, and the restaurants

script used a place called Egrec Zed as the conversation topic. No matter what the participant typed, he or she was ignored while the confederates continued their conversation. This experience was meant to be viewed as rejection by the participants. When the chat room phase reached the eight minute mark, the administrator instructed the members of the chat room: "Ok, time is up. Please fill out the second page of your questionnaire." This questionnaire was identical to the one given following the inclusion phase. Once the questionnaire was completed by the participant, the administrator again indicated the next topic of conversation.

In the third phase, confederates re-included the participant in the discussion. Similar to the first inclusion phase, confederates followed a loose script and made the effort to actively talk with and include the participant in the group's conversation. For example, if the topic was hobbies, the confederates made the effort to ask questions about the participant's hobbies. Once the third phase reached eight minutes, the administrator instructed the members of the chat room: "Ok, time is up. Please fill out the last page of your questionnaire." Again, this questionnaire was identical to the questionnaire filled out after the inclusion and exclusion phases.

Following the conclusion of the final phase, the administrator re-entered the room in which the participant was seated and gave the participant a second packet of questionnaires. After these measures had been completed, participants were fully debriefed regarding the true nature of the experiment. The research team took care to ensure no negative effects of social ostracism persevered after the participant finished the study.

Measures

EEG data was analyzed for this study by first splitting each participant's data to reflect the times each segment of the experiment, including the introductory phase, began and ended. Thus, each approximately 32-minute EEG file was split into four 8-minute files. Each of these

files was then averaged across the 8 minute time span to produce a single set of numbers for each brain region. This set of numbers represented all of the types of brain waves (i.e., alpha, beta, theta, etc.). Because theta is measured from 4 to 8 Hz, the researchers examined the point in each EEG file's average for the brain areas of interest (F_3, F_4, F_z) in which the power was highest between 4 and 8 Hz. This was the target number that was compared for each phase.

There were three main phases in this experiment: inclusion, exclusion, and re-inclusion. After each eight-minute segment, participants responded to the same set of three questions using 5-point Likert scales asking about their enjoyment, interest, and participation in the chat phase, with higher scores reflecting greater enjoyment, interest, and participation (see Appendix 3). This short questionnaire was developed specifically for this study in order to determine participant's impressions of the chat room to supplement the EEG data collected. These variables were analyzed individually, but were also averaged into a *total engagement* variable to reach a more complete view of participants' emotions and opinions regarding each phase of the chat room. A test for Cronbach's alpha indicated these measures were highly reliable, with all scoring above .83.

Participants also completed a more extensive set of questionnaires after completing the final phase of the chat room and before being debriefed. Not all of the measures completed for this section were analyzed in the current study, however. The final questionnaire packet included questions regarding the participant's overall chat room experience using 5-point Likert scales and rated the individual chat room "partners" with whom they interacted using 9-point Likert scales (see Appendix 4). The final questionnaire also inquired about items such as the aversive nature of the chat room, overall enjoyment of the experiment, and qualities of chat room partners. Similar to the short questionnaires completed following the three primary phases,

higher scores on these questionnaires reflected greater overall enjoyment, attractiveness, etc. Lastly, the packet included a demographics section, personality assessment, and Rejection Sensitivity Questionnaire (RSQ). The personality assessment and RSQ were only given to a portion of participants at the conclusion of the rest of the study and were treated as pilot data for future studies, and were not included in analyses in this study.

Design and Analyses

This study utilized multiple repeated-measures analysis of variances (ANOVAs) using frontal lobe brain area (F3, F4, Fz) and experimental phase (inclusion, exclusion, re-inclusion) as within-subjects factors and participant gender (male, female) and physical attractiveness of chat room peers (attractive, unattractive) as between-subjects factors. The main dependent variable used was theta power, but additional dependent variables included level of enjoyment of the online chat room conversation, conversation participation, interest in the conversation and an "overall engagement" variable consisting of the average of enjoyment, participation, and interest. Dependent and independent t-tests were conducted as follow-up measures in order to further determine whether dependent variables showed differences between experimental conditions of inclusion, exclusion, and re-inclusion, and to see whether these differences were moderated by gender and/or attractiveness of ostracizing peers.

Results

Overall Engagement in Chat Room

A mixed design repeated-measures ANOVA using phase (inclusion, exclusion, re-inclusion) as a within-subjects factor and participant gender (male, female) and attractiveness of ostracizing peers (attractive, unattractive) as between-subjects factors was conducted with overall engagement (a combination of interest, participation, and enjoyment) as the dependent

variable. There was a significant main effect for phase, $F(2, 80) = 146.23$, $p = .000$, $\eta^2_p = .79$. Subsequent dependent t-tests revealed that participants reported significantly less overall engagement in the exclusion phase than both the inclusion phase, $t(43) = 13.89$, $p = .000$, and re-inclusion phase, $t(43) = -17.79$, $p = .000$ (Figure 1). There was also significantly higher overall engagement in the re-inclusion phase relative to the inclusion phase, $t(43) = 2.95$, $p = .005$ (Figure 1). There was also a significant main effect for attractiveness such that participants chatting with unattractive peers reported greater engagement in the conversation than those assigned to chat with attractive peers, $F(1, 40) = 5.62$, $p = .023$, $\eta^2_p = .12$ (Figure 2). The main effect for gender was not significant, $F(1, 40) = 3.32$, $p = .076$, $\eta^2_p = .08$. However, there was a significant gender (male, female) by attractiveness (attractive, unattractive) interaction such that the effect of participant gender differed depending on the attractiveness of chat room peers, $F(1, 40) = 7.85$, $p = .008$, $\eta^2_p = .16$. Specifically, independent t-tests revealed that overall level of engagement did not vary greatly between females chatting with attractive and unattractive males, $p > .05$, whereas males chatting with unattractive females reported higher levels of engagement in the chat room than conversations with attractive females, $t(12) = -4.28$, $p = .001$ (Figure 3).

Enjoyment of Chat Room

Although analyzing total engagement indicated overall reactions to the chat room, each self-report variable (enjoyment, interest, participation) was also analyzed independently in order to gain greater insight into the effectiveness of the ostracism manipulation. A mixed design repeated-measures ANOVA using phase (inclusion, exclusion, re-inclusion) as a within-subjects factor and participant gender (male, female) and attractiveness of ostracizing peers (attractive, unattractive) as between-subjects factors was conducted with level of enjoyment as the dependent variable. There was a significant main effect for phase, $F(2, 80) = 72.21$, $p = .000$,

η^2_p = .64. Subsequent dependent t-tests showed a significantly lower level of enjoyment during the exclusion phase in comparison with the inclusion, $t(43) = 9.77$, p =.000, and re-inclusion phases, $t(43) = -11.62$, p =.000. Similar to overall engagement, there was a significant difference between the inclusion and re-inclusion phases with higher levels of enjoyment being reported during re-inclusion, $t(43) = 2.23$, p =.031 (Figure 4). However, no significant gender or attractiveness interactions with phase were found, $p > .05$.

Level of Interest in Chat Room

A mixed design repeated-measures ANOVA using phase (inclusion, exclusion, re-inclusion) as a within-subjects factor and participant gender (male, female) and attractiveness of ostracizing peers (attractive, unattractive) as between-subjects factors was conducted with level of interest as the dependent variable. There was a significant main effect for phase, $F(2, 80) = 61.78$, p = .000, η^2_p = .61. Subsequent dependent t-tests revealed a significantly lower level of interest being reported during exclusion in comparison with the inclusion, $t(43) = 8.74$, p =.000 and re-inclusion phases, $t(43) = -12.37$, p =.000. In addition, t-tests showed a significant difference in interest between inclusion and re-inclusion, with more interest reported during re-inclusion, $t(43) = 3.12$, p =.003 (Figure 4). However, no significant gender or attractiveness interactions with phase were documented, $p > .05$.

Level of Participation in Chat Room

A mixed design repeated-measures ANOVA using phase (inclusion, exclusion, re-inclusion) as a within-subjects factor and participant gender (male, female) and attractiveness of ostracizing peers (attractive, unattractive) as between-subjects factors was conducted with level of participation as the dependent variable. There was a significant main effect for phase, $F(2, 80) = 215.57$, p = .000, η^2_p = .84. Subsequent dependent t-tests revealed significantly lower

participation during exclusion in comparison with the inclusion, $t(43) = 18.26$, $p = .000$ and re-inclusion phases, $t(43) = -20.19$, $p = .000$. Unlike the results for overall engagement, enjoyment, and interest, there was not a significant difference in participation reported between inclusion and re-inclusion, $p > .05$ (Figure 4). There were no significant gender or attractiveness interactions with phase, $p > .05$.

EEG Data

A repeated-measures 3 x 2 x 2 ANOVA with brain area (F_3, F_4, F_z) and phase (inclusion, exclusion, re-inclusion) as within-subjects factors and participant gender (male, female) and attractiveness of ostracizing peers (attractive, unattractive) as between-subjects factors was conducted with theta power as the dependent variable. No main effect was found for brain area, so the three frontal brain areas of F_3, F_4, and F_z were collapsed into one total frontal lobe theta power score for further analysis.

There was no significant effect for phase, $F(2, 80) = 1.19$ $p = .310$, $\eta^2_p = .03$ (Figure 5). However, there was an interaction between phase and attractiveness such that the impact of experimental phase differed depending on the attractiveness of ostracizing peers, $F(1, 40) = 4.20$, $p = .018$, $\eta^2_p = .10$. A follow-up ANOVA focusing on the group assigned to chat with attractive peers using phase as a within-subjects factor and theta power as the dependent variable showed a non-significant trend for phase, $F(2, 34) = 2.668$, $p = .082$. A dependent t-test conducted using the group assigned to chat with attractive peers suggests this difference is occurring between inclusion and exclusion, with there being a more substantial drop in theta power from inclusion to exclusion, $t(17) = 1.858$, $p = .081$. No other subsequent tests approached significance, $p > .05$. The follow-up ANOVA conducted with the group assigned to chat with unattractive peers using

phase as a within-subjects factor and theta power as the dependent variable showed no significant effects, $p > .05$ (Figure 6).

Discussion

Lack of enjoyment, reduced interest in social interaction, and refusal to engage are all negative impacts of social ostracism; thus, the results of this study support past research that has found that ostracism is a negative experience (Bastian & Haslam, 2010; Boyes & French, 2009; Eisenberger, Lieberman, & Williams, 2003; Kawamoto et al., 2012). Results from the current study suggest that social ostracism has both behavioral and emotional components, supporting past research on the negative impact of social ostracism while using a novel exclusion paradigm. This study found significant effects for exclusion and re-inclusion in self-report measures, although changes in the self-report measures were not always accompanied by changes in the EEG data. Results indicated that attractiveness had a significant impact in self-report as well as EEG data and were mixed regarding the impact of gender on the experience of social ostracism as measured by self-reports and frontal theta power.

Exclusion Phase

Participants in the present study reported significantly less overall engagement, enjoyment, interest, and participation in the conversation when they were excluded by the confederates. This demonstrates that confederates in this study were successful in making participants feel ostracized, and participants' behavior reflected a withdrawal from the conversation in response to this ostracism. Although the current study used a chat room paradigm rather than a cyber ball-tossing game as in previous research and did not specifically measure levels of distress (Boyes & French, 2009), the current study's results were congruent with past research and confirm ostracism's negative effects on social interactions (Eisenberger,

Lieberman, & Williams, 2003). However, the results seen in self-report data did not correlate well with EEG data.

Prior studies have shown that the frontal lobe is involved in responses to social ostracism (Kawamoto et al., 2012) and have found a reduction in theta power is associated with negative emotions (Aftanas & Golocheikine, 2001). Based on these findings and previous research in our laboratory, we anticipated a significant reduction in frontal theta power during the experiment's exclusion phase compared with the inclusion and re-inclusion phases. Although theta power did decrease during exclusion, there was not a statistically significant difference.

There are several possible reasons that this study failed to find a significant difference in frontal theta EEG activity during the exclusion phase compared with the inclusion and re-inclusion phases. Past research has shown discrepancies regarding the role of theta, with some studies reporting a reduction in theta power during the experience of negative emotions such as frustration (Aftanas & Golocheikine, 2001) and other studies reporting that theta power increases with the intensity of emotion (Ertl et al., 2013). In other words, studies agree that theta is involved in emotional processing, but results are not clear in which direction this activity can be found.

However, the present study does not see a significant rise or fall in theta power during exclusion. An explanation for this effect could be that averaging theta waves over an eight-minute period potentially provided participants a long enough time to deal with the ostracism and rationalize that it could have been part of the experiment, therefore lessening the effect of ostracism on theta activity. For instance, theta power might be significantly decreased during the first few minutes of exclusion, but another frontal lobe mechanism might compensate for the negative emotions accompanying ostracism, thereby reducing the significance of this effect. It

would be helpful for future studies to explore this effect further in order to determine if theta is involved in detecting or dampening social pain associated with ostracism. One way to explore this research question would be to split the current 8-minute periods into shorter 4-minute intervals. It is possible that if a significant effect for theta activity is seen within the first 4 minutes, then theta might be more responsible for the detection of ostracism. Conversely, if an effect is seen in the last 4 minutes of the exclusion phase, theta could be a mechanism responsible for the reduction of social pain. Another possibility that could be explored in a future study would be to give participants a dial on which emotion is constantly monitored, which could allow researchers to correlate self-reported changes in emotion from second to second with changes in frontal lobe theta EEG activity.

In addition, this study only analyzed theta activity, but other bands of different frequencies, such as alpha and beta (Aftanas & Golocheikine, 2001), could shed light on the experience of ostracism as well. It is likely that ostracism affects other brain regions involved in the processing of pain, which could be reflected in different EEG wave frequencies, and this knowledge would add to the current body of ostracism research. Perhaps other frequencies already found in the current study's data could also provide insight into the impact of gender and attractiveness of peers on the ostracism experience.

The addition of the variables of gender and attractiveness in the analyses for the current study also could have confounded the EEG results. A past study conducted in our laboratory found a significant reduction in theta power during exclusion, but the previous study included only female participants and did not include different attractiveness conditions. By adding attractiveness and gender as variables, previously significant effects could have been reduced to non-significant levels, either due to a presence of an effect in one group and not another, or due

to lack of power because of small cell sizes. Future research in this area is necessary to explore these possibilities.

Re-inclusion Phase

A re-inclusion phase was included in the current study in order to answer the question of whether the negativity associated with the exclusion phase was so pervasive that participants were unable to rebound emotionally, or whether the re-inclusion phase was experienced in a way similar to the inclusion phase. Past research has often investigated differences between inclusion and exclusion, but has not investigated the effects of a re-inclusion phase (Boyes & French, 2009; Eisenberger, Lieberman, & Williams, 2003). While a significant negative impact was hypothesized for exclusion in comparison with inclusion and re-inclusion, no differences were predicted comparing re-inclusion to the first inclusion phase of the chat room in this study, based on previous findings in our laboratory.

Results showed not only the expected significant difference between exclusion and re-inclusion, but also a significant difference between inclusion and re-inclusion total engagement, enjoyment, and level of interest, with the re-inclusion phase being rated higher than the original inclusion phase. It is possible that the accompanying emotions during inclusion were different or more pronounced during re-inclusion. Previous research has established that negative emotions accompany ostracism (Bastian & Haslam, 2010; Bastian et al., 2013). Therefore, going from complete exclusion to re-inclusion could have increased positive emotion more significantly than the positive emotions experienced during the original inclusion phase. Participants might have expected to be included in the chat room originally, and the first phase therefore could have made a lesser impact on positive emotions and engagement in the chat room. The positive impact

of re-inclusion could have been much higher after exclusion, thus leading to the differences seen between inclusion and re-inclusion.

However, a difference between inclusion and re-inclusion was not found for the variable of self-reported participation in the chat room. Due to the same amount of time being allotted for each phase, the researchers believe that it would have been difficult for participants to type significantly more during the re-inclusion phase compared with the inclusion phase, so it is unsurprising that a behavioral variable such as participation would not be significantly altered between inclusion and re-inclusion.

Despite significant results for self-report data, differences between the re-inclusion and inclusion phase were not reflected in frontal EEG data. Factors that could have affected the re-inclusion phase and led to non-significant results include the introduction of attractiveness and gender as variables, the averaging of frontal EEG activity over an 8-minute period, and the possibility that a change in theta activity occurs in other brain regions during re-inclusion. Further research will be necessary to further explore this effect.

Attractiveness Manipulation

Results from the current study indicate that the attractiveness of peers did alter the way in which participants viewed ostracism in self-reports. Specifically, participants actually reported greater overall engagement in conversations with unattractive peers in comparison with attractive peers. This result may seem counter-intuitive, as most children are taught by society to expect the best social interactions with attractive individuals (Aronson, Wilson, & Akert, 2010) and past studies have documented that level of attractiveness is positively correlated with quality of social interactions (Reis, Nezlek, & Wheeler, 1980). However, the main effect for attractiveness in this study could have occurred for a variety of reasons. Perhaps unattractive individuals are viewed

as less threatening in a novel social situation, leading to higher levels of engagement. On the other hand, it is possible that being socially ostracized by more attractive individuals was more aversive than being ostracized by less attractive peers and this could have brought down the overall means for enjoyment, participation, and interest. It is possible that it was more hurtful for participants to be ostracized by attractive individuals, thus pulling down the overall mean for engagement with attractive chat room peers, leading to the division between attractive and unattractive groups. Theta power showed a reduction in the exclusion phase in EEG analysis, with the attractive group showing a larger reduction in theta power during exclusion, so the latter explanation seems more plausible.

EEG data reflected a significant interaction between phase and attractiveness of ostracizing peers, although subsequent follow-up analyses were not significant. The attractiveness hypothesis for the current study was that those assigned to the attractive condition would show a greater reduction in frontal theta power during the exclusion phase in comparison with those assigned to the unattractive peers group. Results showed a reduction in theta power during the exclusion phase for those chatting with attractive individuals, making it appear that being ostracized by attractive peers might alter the brain more than being ostracized by less attractive peers. However, this trend was not significant. Most studies dealing with attractiveness are not investigating ostracism by attractive individuals, but rather the assumption that attractive people possess positive social traits, such as a desire to include others (Adams, Hicken, & Salehi, 1987; Aronson, Wilson, & Akert, 2010; Dion, Berschied, & Walster, 1972). Due to the expectation of positive social interactions with attractive individuals, it is possible that frontal theta activity was reduced (although not enough to be significant) because participants found it more difficult to cope with ostracism by peers who were expected to be inclusive. Because this

effect did not reach significance, it is important for future studies to continue to utilize EEG measures to analyze the effect of attractiveness in social ostracism.

Follow-up t-test analyses could have failed to reach significance for a variety of reasons. One potential explanation is that participants in this study could have experienced more unpleasant emotions in response to ostracism by attractive peers, but that an eight-minute window for EEG analysis gave them enough time to move past the ostracism, thus weakening results. Future research should consider analyzing smaller bits of each phase in order to test whether this hypothesis is correct. Another limitation to this manipulation was unequal distribution among attractiveness conditions. After screening out of participants due to noisy EEG data, there were 18 participants (5 male, 13 female) assigned to the attractive peers condition and 26 participants (9 males, 17 females) assigned to the unattractive peers condition. While a total number of 44 participants is acceptable for similar EEG studies, this imbalance between conditions could have led to non-significant results. In addition, although the study initially had equal numbers in each group via random assignment, the researchers found an imbalance in numbers of participants between attractiveness conditions after some participants were screened out of analyses due to noisy EEG data. These groups had originally been counterbalanced in order to produce equal group sizes, but researchers found that many more participants in the attractive condition were screened out due to noisy EEG data. As excessive noise in EEG data is often due to extraneous movement by the participant, one potential explanation for this discrepancy is that individuals move around more physically when ostracism becomes more aversive, and perhaps it was more aversive for participants in the current study to be excluded by attractive peers. Future studies could record behaviors to determine whether this is a factor.

Another possible explanation of this small effect for attractiveness is that the pictures in the chat room were very small, which could have lessened the impact of attractiveness on the social climate in the chat room. If a participant decided to click on the profile of another member of the chat room, a much larger picture could be viewed, but participants were not instructed to do so and few did this of their own accord. Thus, it is possible that attractiveness played a smaller role than expected due to these factors. However, since there were significant effects of attractiveness on behavior, this seems less likely.

Gender and Social Ostracism

A significant interaction was found between attractiveness and gender in self-report data. Specifically, females showed little difference in overall engagement regardless of whether they chatted with attractive or unattractive males, but male participants showed a much larger difference in overall engagement based upon whether the females they entered the chat room with were attractive or unattractive, with male participants showing greater engagement with unattractive females. This finding could have been due to a combination of factors: first of all, participants were paired in the online chat room with those of the opposite sex, and males in the study could have been aware that females are more likely to ostracize others (Benenson et al., 2011). It is also possible that the males in the current study felt threatened by the attractive female confederates, leading to an overall decrease in the engagement scores of male participants assigned to the attractive condition relative to male participants assigned to the unattractive condition.

Despite a significant interaction between gender and attractiveness of peers in overall engagement, the EEG data did not reflect any significant gender effects. A possible explanation for weakened EEG results in this area is that ostracism might be perceived as more severe when

it is enacted by same-gender rather than opposite-gender peers, as found by Bolling, Pelphrey, and Vander Wyk (2012). In previous studies, brain activation measured by fMRI in areas dealing with social ostracism has increased during exclusion by those of the same gender, but not during exclusion by those of the opposite gender. This suggests a more negative reaction to ostracism by same-gender peers, a combination not explored in the current study. It is important for future ostracism research to elaborate upon the current study by examining new combinations of gender in online chat rooms. For instance, a future study could include chat rooms made up of same-sex groups, rather than participants being paired with two others of the opposite gender. Other combinations of gender should also be explored in order to determine whether different gender combinations produce similar results.

This study had many more female (N = 30) than male (N = 14) participants. Fourteen is a very low number of participants for one cell to see EEG effects, especially when these cells are further broken down by attractiveness. It is likely that this imbalance occurred because a greater number of female students attend the university and most Psychology classes are skewed in terms of gender, with more females than males enrolling. Should more data be collected and added to the current study, this gender imbalance should be remedied in order to reach equal numbers of each gender, because this gender distribution could have skewed results or prevented an effect from becoming significant due to lack of power.

Limitations and Future Directions

One limitation not yet mentioned is this study's sample. Participants in this study were primarily freshman and sophomores at Illinois Wesleyan University. The student body at the university is composed primarily of white, Midwestern, heterosexual students. These characteristics reduce this study's ability to generalize beyond students of these ages living in the

Midwest. Future studies could focus on the younger teenage population, who could be at greater risk for the negative effects of social ostracism via online social media platforms due to their greater usage of social media and still-developing frontal lobes (Beckman, 2004).

In addition, it is possible that results could be altered if participants are in a chat room with friends or acquaintances, in contrast with unknown students from other universities. The EEG data already collected from this study also includes recordings from other brain regions that could be analyzed for reactions to social ostracism as well as different wave frequencies, such as the 8-12 Hz alpha EEG pattern, that have been analyzed in past research (Aftanas and Golocheikine, 2001) and which should be considered in future studies. Lastly, future research could examine personality variables, such as sensitivity to rejection and extroversion, in order to determine whether certain personalities predispose individuals to be more affected by social ostracism.

Conclusion

This study found self-report data to support past research that social ostracism is a negative experience that leads to reduced enjoyment, interest, participation, and overall engagement in social interactions. However, the EEG data as a whole did not reflect the differences found in the self-report data. This could be due to a variety of confounds, such as the addition of attractiveness and gender as variables or averaging frontal theta power over an 8-minute period. Future studies will be helpful in further exploring the effects of social ostracism using an online chat room paradigm. This study's contribution to the current body of literature lies in its applicability to online social media habits, especially those of teens and young adults. The current study was able to confirm previously documented negative effects of social ostracism with the use of a novel online chat room paradigm, which is very similar to online

platforms popular today. Results from this study demonstrate the need for social ostracism to be taken seriously, and to continue to be studied in order to reach a fuller understanding of the underlying mechanisms involved in varying ostracism experiences.

References

Adams, G. R., Hicken, M., & Salehi, M. (1987). Socialization of the physical attractiveness stereotype: parental expectations and verbal behaviors. *International Journal of Psychology, 23(1-6)*, 137-149.

Aftanas, L. I., Golocheikine, S. A. (2001) Human anterior and frontal midline theta and lower alpha reflect emotionally positive state and internalized attention: high-resolution EEG investigation of meditation. *Neuroscience Letters, 310*, 57-60.

Aronson, E., Wilson, T. D., & Akert, R. M. (2010). Physical attractiveness and liking. In L. Jewell, J. Marshall, L. Doherty, & A. Trudell (Eds). *Social Psychology* (pp. 293-299). Upper Saddle River, NJ: Prentice Hall.

Asada, H., Fukada, Y., Tsunoda, S., Yamaguchi, M., & Tonoike, M. (1999). Frontal midline theta rhythms reflect alternative activation of prefrontal cortex and anterior cingulated cortex in humans. *Neuroscience Letters, 274*, 29-32.

Bastian, B., Jetten, J., Chen, H., Radke, H. R. M., Harding, J. F., & Fasoli, F. (2013). Losing our humanity: The self-dehumanizing consequences of social ostracism. *Personality and Social Psychology Bulletin, 39(2),* 156-169.

Bastian, B., & Haslam, N. (2010). Excluded from humanity: The dehumanizing effects of social ostracism. *Journal of Experimental Social Psychology, 46(1),* 107-113.

Beckman, M. (2004). Crime, Culpability, and the Adolescent Brain. *Science, 305*, 596-599.

Benenson, J. F., Markovits, H., Thompson, M. E., & Wrangham, R. W. (2011). Under threat of social exclusion, females exclude more than males. *Psychological Science, 22(4),* 538-544.

Bolling, D. Z., Pelphrey, K. A., & Vander Wyk, B. C. (2012). Differential brain responses to social exclusion by one's own versus opposite-gender peers. *Social Neuroscience, 7(4),* 331-346.

Boyes, M. E., & French, D. J. (2009). Having a cyberball: Using a ball-throwing game as an experimental social stressor to examine the relationship between neuroticism and coping. *Personality and Individual Differences, 47(5),* 396-401.

Campbell, M., Spears, B., Slee, P., Butler, D., & Kift, S. (2012). Victims' perceptions of traditional and cyberbullying, and the psychosocial correlates of their victimization. *Emotional & Behavioural Difficulties, 17(3-4),* 389-401.

Coghill, R. C., Sang, C. N., Maisong, J. M., & Iadarola, M. J. (1999). Pain intensity processing within the human brain: a bilateral, distributed mechanism. *Journal of Neurophysiology, 82(4),* 1934-1943.

Davidson, R. J. (2004). What does the prefrontal cortex "do" in affect: perspectives on frontal EEG asymmetry research. *Biological Psychology, 67,* 219 –233.

DeWall, C. N., & Richman, S. B. (2011). Social exclusion and the desire to reconnect. *Social and Personality Psychology Compass, 5('11),* 919-932.

Dion, K., Berscheid, E., & Walster, E. (1972). What is beautiful is good. *Journal of Personality and Social Psychology, 24(3),* 285-290.

Duggan, M., & Brenner, J. (2013). *The demographics of social media users – 2012.* Retrieved from Pew Research Center website.

Eisenberger, N. I., & Cole, S. W. (2012). Social neuroscience and health: Neurophysiological mechanisms linking social ties with physical health. *Nature Neuroscience, 15(5),* 669-674.

Eisenberger, N. I., Inagaki, T. K., Muscatell, K. A., Haltom, K. E. B., & Leary, M. R. (2011). The neural sociometer: Brain mechanisms underlying state self-esteem. *Journal of Cognitive Neuroscience, 23(11),* 3448-3455.

Eisenberger, N. I., Jarcho, J. M., Lieberman, M. D., & Naliboff, B. D. (2006). An experimental study of shared sensitivity to physical pain and social rejection. *Pain, 126(1-3),* 132-138.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt? an fMRI study of social exclusion. *Science, 302(5643),* 290-292.

Eisenberger, N. I., & Lieberman, M. D. (2004). Why rejection hurts: A common neural alarm system for physical and social pain. *Trends in Cognitive Sciences, 8(7),* 294-300.

Eisenberger, N. I. (2012). Broken hearts and broken bones: A neural perspective on the similarities between social and physical pain. *Current Directions in Psychological Science, 21(1),* 42-47.

Eisenberger, N. I. (2012). The neural bases of social pain: Evidence for shared representations with physical pain. *Psychosomatic Medicine, 74(2),* 126-135.

Eisenberger, N. I. (2006). Identifying the neural correlates underlying social pain: Implications for developmental processes. *Human Development, 49(5),* 273-293.

Ertl, M., Hildebrandt, M., Ourina, K., Leicht, G., & Mulert, C. (2013). Emotion regulation by cognitive reappraisal-the role of frontal theta oscillations. *Neuroimage, 81*, 412-421.

Hadland, K. A., Rushworth, M. F. S., Gaffan, D., & Passingham, R. E. (2003). The anterior cingulated and reward-guided selection of actions. *Journal of Neurophysiology, 89*, 1161-1164.

Iidaka, T., Omori, M., Murata, T., Kosaka, H., Yonekura, Y., Okada, T., & Sadato, N. (2001). Neural interaction of the amygdala with the prefrontal and temporal cortices in the

processing of facial expressions as revealed by fMRI. *Journal of Cognitive Neuroscience, 13(8)*, 1035-1047.

Kawamoto, T., Onoda, K., Nakashima, K., Nittono, H., Yamaguchi, S., & Ura, M. (2012). Is dorsal anterior cingulate cortex activation in response to social exclusion due to expectancy violation? an fMRI study. *Frontiers in Evolutionary Neuroscience, 4 Jul*, Art 11.

Kowalski, R. M., & Limber, S. P. (2013). Psychological, physical, and academic correlates of cyberbullying and traditional bullying. *Journal of Adolescent Health, 53(1),* S13-S20.

Knyazev, G. G., Slobodskoj-Plusnin, J. Y., & Bocharov, A. V. (2010). Gender differences in implicit and explicit processing of emotional facial expressions as revealed by event-related theta synchronization. *Emotion, 10(5),* 678-687.

Lopez-Sola, M., Pujol, J., Hernandez-Ribas, R., Harrison, B. J., Ortiz, H., Soriano-Mas, C., Deus, J., Menchon, J. M., Vellejo, J., and Cardoner, N. (2010). Dynamic assessment of the right lateral frontal cortex response to painful stimulation. *NueroImage, 50(3)*, 1177-1187.

Mobbs, D., Marchant, J. L., Hassabis, D., Seymour, B., Tan, G., Gray, M., . . . Frith, C. D. (2009). From threat to fear: The neural organization of defensive fear systems in humans. *The Journal of Neuroscience, 29(39),* 12236-12243.

Putman, P., van Peer, J., Maimari, I., & van der Werff, S. (2010). EEG theta/beta ratio in relation to fear-modulated response-inhibition, attentional control, and affective traits. *Biological Psychology, 83*, 73-78.

Rainville, P. (2002). Brain mechanisms of pain affect and pain modulation. *Current Opinion in Neurobiology, 12(2),* 195-204.

Rainville, P., Duncan, G. H., Price, D. D., Carrier, B., & Bushnell, M. C. (1997). Pain affect encoded in human anterior cingulate but not somatosensory cortex. *Science, 277(5328),* 968-971.

Reis, H. T., Nezlek, J., Wheeler, L. (1980). Physical attractiveness in social interaction. *Journal of Personality and Social Psychology, 38(4)*, 604-617.

Reis, H. T., Wheeler, L., Spiegel, N., Kernis, M. H., Nezlek, J., & Perri, M. (1982). Physical attractiveness in social interaction II: why does appearance affect social experience? *Journal of Personality and Social Psychology, 43(5)*, 979-996.

Renn, R., Allen, D., & Huning, T. (2013). The relationship of social exclusion at work with self-defeating behavior and turnover. *The Journal of Social Psychology, 153(2),* 229-249.

Riva, P., Romero Lauro, L. J., DeWall, C. N., & Bushman, B. J. (2012). Buffer the pain away: Stimulating the right ventrolateral prefrontal cortex reduces pain following social exclusion. *Psychological Science, 23(12),* 1473-1475.

Schneider, K. T., Hitlan, R. T., & Radhakrishnan, P. (2000). An examination of the nature and correlates of ethnic harassment experiences in multiple contexts. *Journal of Applied Psychology, 85,* 3–12.

Slavich, G. M., Way, B. M., Eisenberger, N. I., & Taylor, S. E. (2010). Neural sensitivity to social rejection is associated with inflammatory responses to social stress. *PNAS Proceedings of the National Academy of Sciences of the United States of America, 107(33),* 14817-14822.

Twenge,, J. M., Catanese, K. R., & Baumeister,, R. F. (2003). Social exclusion and the deconstructed state: time perception, meaninglessness, lethargy, lack of emotion, and self-awareness. *Journal of Personality and Social Psychology, 85(3)*, 409-423.

Wolke, D., Copeland, W. E., Angold, A., & Costello, E. J. (2013). Impact of bullying in childhood on adult health, wealth, crime, and social outcomes. *Psychological Science 24(10)*, 1958-1970.

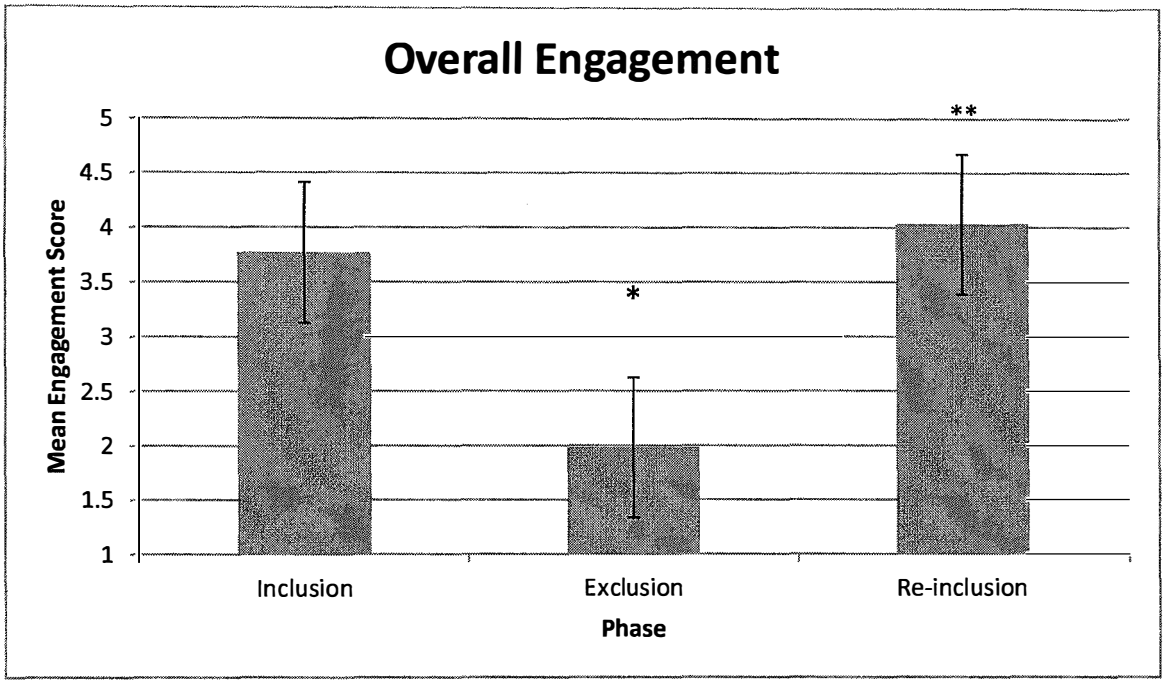

Figure 1. Behavioral Data -- Overall Engagement (Interest, participation, and enjoyment combined). Main effect for phase, with exclusion being significantly lower than inclusion or re-inclusion, and re-inclusion being significantly higher than inclusion.

*Exclusion phase differed significantly from inclusion and re-inclusion phases, $p < .05$
** Re-inclusion phase differed significantly from inclusion phase, $p < .05$

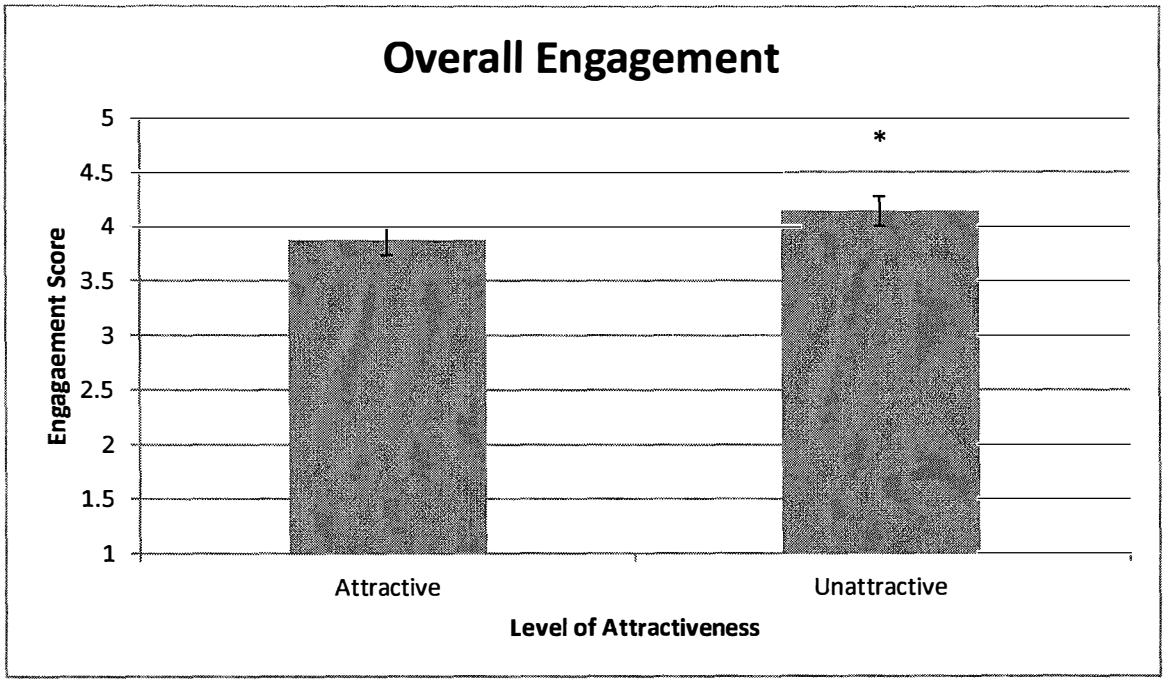

Figure 2. Main effect for attractiveness, with overall engagement being significantly higher in the group assigned to chat with unattractive peers.

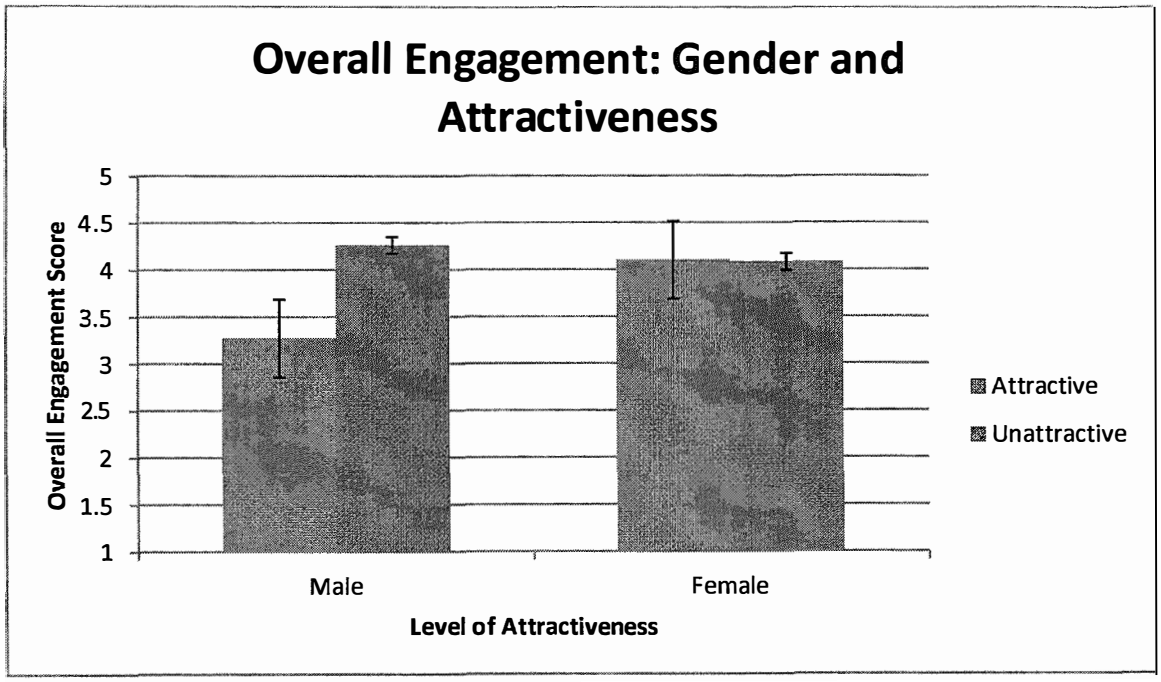

Figure 3. Interaction between gender and attractiveness.

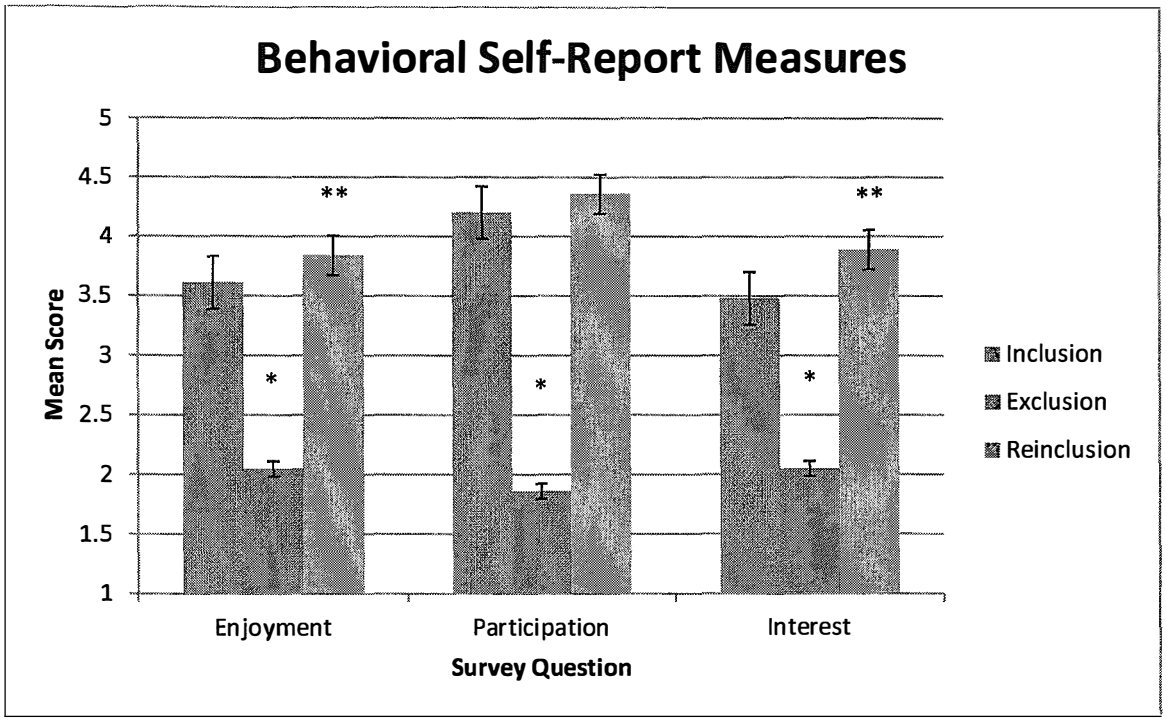

Figure 4. Participant enjoyment, participation, and interest in chat room conversations during inclusion, exclusion, and re-inclusion phases. Bars represent average scores reported by participants following each phase.

*Exclusion phase differed significantly from inclusion and re-inclusion phases, $p < .05$
** Re-inclusion phase differed significantly from inclusion phase, $p < .05$

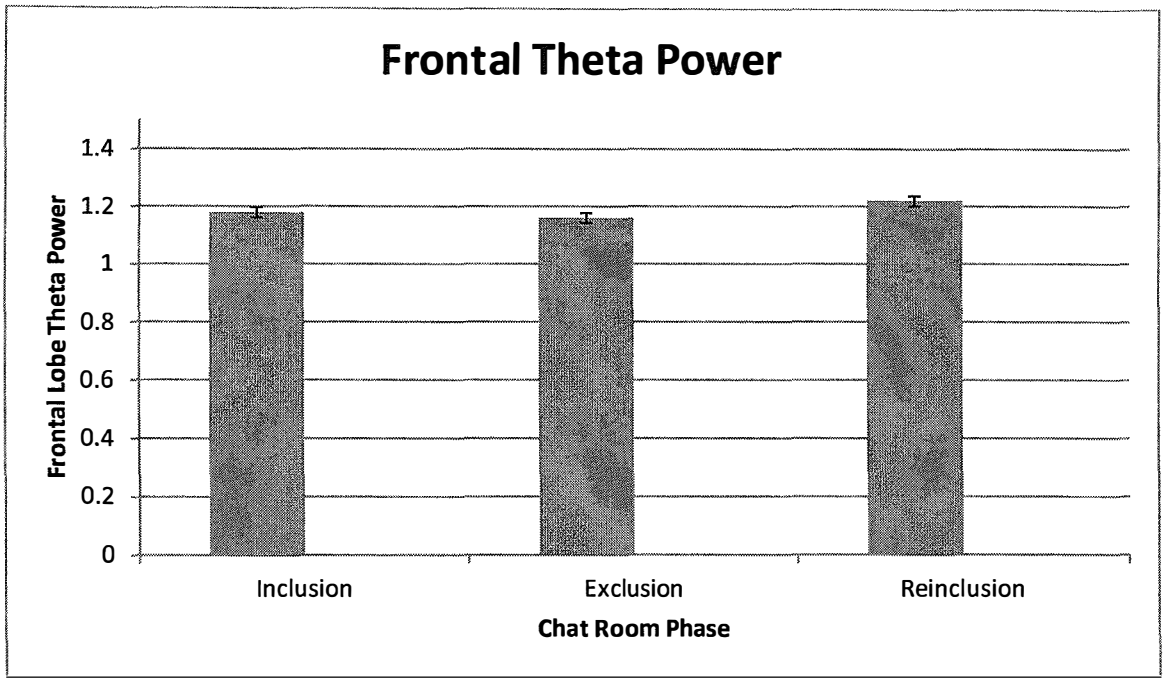

Figure 5. Frontal lobe theta power during experimental phases. Error bars represent standard error. None of the phases were found to significantly differ from one another, $p > .05$. However, there is a numerical trend with the exclusion phase having lowered theta power relative to the inclusion and re-inclusion phases.

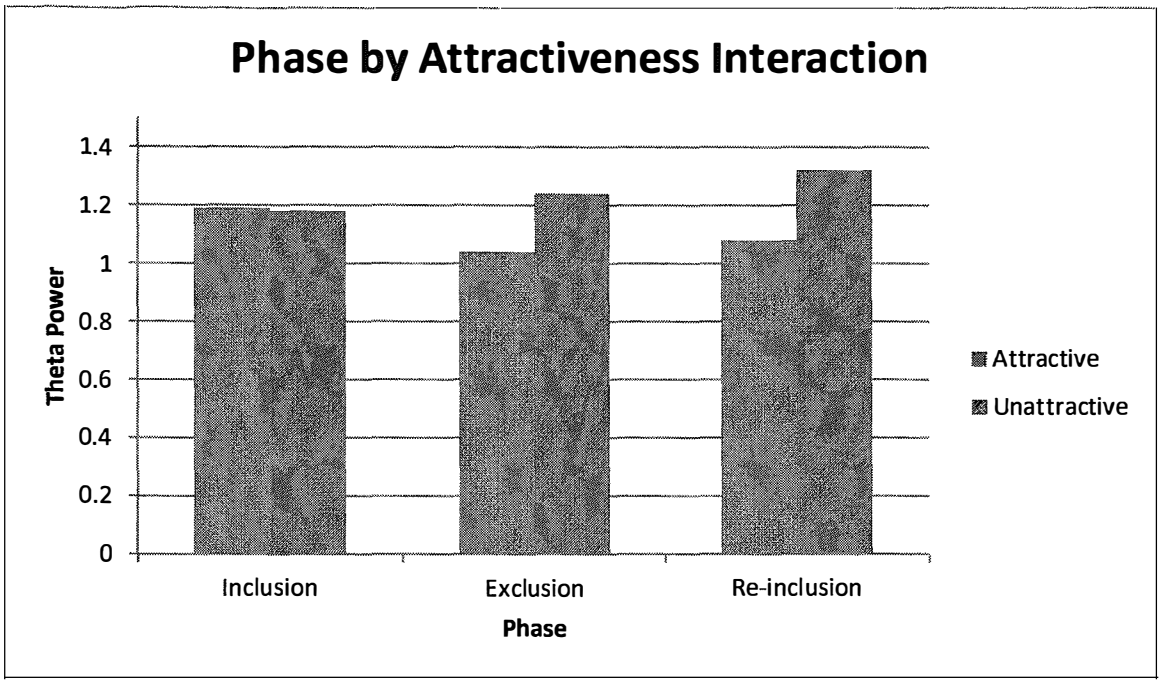

Figure 6. Phase by attractiveness interaction. This figure demonstrates the larger differences between attractiveness groups during exclusion and re-inclusion.

Appendix 1

Profile

[Picture here]

Name: Jessica

Age: 19

Sex: Female

Major: Nursing

University: University of Illinois

Favorite Movies: Beauty and the Beast, Sleepless in Seattle, Lady and the Tramp

Favorite Books: Eat, Pray Love; The Brothers K; The Time Traveler's Wife

Favorite Bands: Keith Urban, Kenny Chesney, John Mayer

Favorite Sports: Softball

Activities/ Interests: Shopping, hanging out with friends, roller coasters, relaxing at the beach

Appendix 2

Ostracism Script: Restaurant

Admin: Ok, time's up. Please take the next eight minutes to talk about your favorite restaurant.

Stu. 1: Well I haven't gone out to eat too much lately, my budgets pretty tight being a poor college student

Stu. 2: Yeah agreed. The last time I went to my favorite restaurant was on my birthday over the summer with my parents. It's this place called Egrec Zed

Stu. 1: Wait really? I love that place!

Stu. 2: Yeah, it's the best. Way too expensive for me to go without my family through.

Stu. 2: It's so different from any other restaurant too that's what I love about it.

Stu. 1: I know I can't think of another place even similar to it.

Stu. 2: And the service is awesome-the chefs all have interesting stories to share when they stop at your table.

Stu. 1: Ya, I actually found out about it because a family friend was hired as one of the chefs.

Stu. 2: Woah that's awesome…free food lol

Stu. 1: Haha I wish!!!

Stu. 2: I love the inside atmosphere too the giant fire pits everywhere are really cool

Stu. 1: Ya I can't believe how many they have.

Stu.1: Have you ever sat on the outdoor terrace on the roof?

Stu. 2: No, just on the main floor. I want to though…

Stu. 1: The city looks really good from up there it's perfect in the summer at night

Stu. 1: Probably my favorite part

Stu. 2: Well I think my favorite part is every time you go they have different dishes. I've gotten lamb and red belly swordfish, and orange chicken all in the same meal.

Stu. 1: Mmmm I'm getting hungry. My favorite is all the varieties of meat. You can't go wrong…unless you're a vegetarian hah

Stu. 2: The salad bar is amazing though I think there is something for everyone.

Stu.1: Ya true. I love how they bring it to you and you can pick and choose.

Stu. 2: And I almost forgot about the little rock!!!

Stu. 1: Oh yeah, the "signal-for-food" as they like to call it. So cool

Stu. 2: They have some really interesting side dishes too on that big buffet table

Stu. 2: I think some of its really good…sometimes they have some weird stuff though

Stu. 1: haha… ya some is definitely different. I always get that weird mint salad…my dad said you're supposed to eat it between meats.

Stu. 2: Yeah I've had that too…I actually like that salad a lot!

Stu. 2: Gosh I wish we had some of their dessert right now. They brought out the best bday cake for me

Stu. 1: I bet. I love the banana soufflé

Stu. 2: That sounds good too. I'm not a huge fan of banana though

Stu. 1: They also have rice pudding, but they put this unique sauce on top. You ever tried it??

Stu. 2: Nope wish I had…whats it like?

Stu. 1: Well I think they get the spices from South America…Peru maybe

Stu 2: oh yea now that you mention it I think I remember. Is it red with little purple berries?

Stu. 1: Exactly that's the one. Delicious!

Stu. 2: Next time I am for sure trying that out

Stu. 1: Good, you should

Stu. 2: The area downtown near there is really nice too

Stu.1: Yeah its so nice! One time when I went, my family was staying downtown and we were waiting for a cab after eating and this bus pulled up

Stu. 1: They have like their own mini bus to transport you around the city

Stu. 2: Oh yea! I do remember seeing it, we parked though

Stu. 1: Yeah its so nice. I've seen it driving around downtown a couple other times

Stu.2: Good advertising!

Stu .1: Yeah you know it

Stu. 2: This conversation is making me so hungry hah. I just want to go out to eat there

Stu 1: Ya its seriously the best

Ostracism script: TV

Stu.1: I'm going to have to say my favorite T.V.show it The Increasingly Poor Decisions of Todd Margaret.

Stu.2: Really that's crazy, that's my favorite T.V. show, David Cross is the man.

Stu.1: Hahahaha THUNDER MUSCLE!!!

Stu.2: This show is hilarious. How'd you find out about it?

Stu.1: I dunno I saw a preview on the internet and it was so funny I had to give the show a chance. Plus I really like Will Arnett too haha

Stu.2: Yea, I hear ya, the only thing that sucks is the show comes on Friday night so I miss a lot of the episodes.

Stu.1: Yea me too but I usually catch the encore episodes on Tuesdays

Stu.2: Really? Damn I should just watch it then

Stu.1: Did you see the season premier? I was dying

Stu.2: Hahah yea a north Korean energy drink called thunder, I mean you can't go wrong with that combination

Stu.1: Hahaha true I also like how they start the show every episode.

Stu.2: Yea hahaha I'm curious to see what he did to land himself in jail.

Stu.1: Well hahhah he has now idea of British culture or sales so anything is possible

Stu.2: And only one employee ahah

Stu.1: Yea, not really the combination for a successful business

Stu.2: Hahah yea

Stu.1: I guess the only thing he has going for him is that he can lie quite well.

Stu.2: Yeaaa but the more he lies the deeper and deeper he goes down the rabbit hole so who knows what will result from his constant lying.

Stu.1: I have a feeling Alice is eventually going to find out everything and leave his ass hahaah

Stu.2: Ooo I know I was think the same. Did you see the commercial they made to publicize the drink?

Stu.1: Ahah of course, I've seen every episode so far. I mean the shows absolutely ridiculous

Stu.2: Yeaaa me too the show def has some potential.

Stu.1: I would not want to try Thunder Muscle either ahahh looks gross

Stu.2: Ooo I know hahah its so funny though how he tries to sell it to the British people

Stu.1: Hahah I know it kind of reminds me of Borat how messes with people so much

Stu.2: Hahah I love how he swears so much too, its hilarious

Stu.1: Did you see the part when he drank one of those energy drinks in the coffee shop?

Stu.2: Ahahahahahahahahaahahahahahahahahahahah, one of those energy drinks

Stu.1: Hah good point. When he drank SEVERAL of those energy drinks?

Stu.2: Yea that was by far one of the funniest scenes in the season.

Stu.1: I pretty much lost it when he started going crazy on those drinks and then hit his head on the light

Stu.2: Hahah then he got knocked out and fell on the table

Stu.1: Its pretty much the U.S. just bashing on Britain

Stu.2: Hahah "your country sucks"

Stu.1: Yeasss I'm pretty sure your not going to sell anything when you insult their country

Stu.2: "Come one people it's only a pound, BUY ONE"

Stu.1: Haha everyone just runs away then…classic

Stu.2: They better continue to make this show

Stu.1: I mean the first episode aired in the beginning of October so lets just hope enough people see it so they can make another season.

Stu.2: Yea I think there's only been like 6 episodes and it's doesn't help its on the IFC channel.

Stu.1: True, I'm surprise you've been heard of it, I thought like I was the only one who knew about

Stu.2: Haha yea same here

Ostracism script: Hobbies
Admin: Ok, time's up. Please take the next eight minutes to talk about your favorite hobbies or interests

Stu.1: Hmmm well this may sound a bit weird but I kinda like doing origami when I'm bored.

Stu.2: That's not that weird I like all forms or art, so I'm pretty familiar with origami

Stu.1: Ha cool, where did you come across origami, its kind of a lost art if you know what I mean

Stu.2: Well like I said I like art so I've taken plenty of art classes in high school and college so I've kind of just came across it over the years hahah. What about you?

Stu.1: Well everyday Sunday my family and I spend time with my grandma and she absolutely loves it. She's been doing it ever since she was young, and eventually passes down her knowledge and skills to me.

Stu.2: At first I absolutely hates it because it was pretty hard and meticulous, and even a little boring.

Stu.1: Hahah yea

Stu.2: But soon after a little practice I started to get a little better and started creating these sweet shapes that didn't really resemble anything hahah. Have you ever made anything?

Stu.1: Trust me its not just you. When I first tried making a simple flower it looked more like a deformed turtle. Hahahaha

Stu.2: But yea once I got better I was able to make some intricate flowers, an animal here and there, and my proudest creation a Christmas wreath that I made for my mom for Christmas.

Stu.1: Ahahah that's awesome, my mom would love something like that

Stu.2: I've pretty much perfected the flower, it gets pretty easy to do after awhile because it's the same procedure over and over again until basically you can do it with ease barely looking at it.

Stu.1: What are some of the things that you've made?

Stu.2: Well my grandma loves making animals like bears, dragons, and of course swans, but I'm more into making abstract designs that really don't stand for anything.

Stu.1: Haha that's kinda cool what do some of your designs look like?

Stu.2: Its hard to explain but one I'm working on now looks like a huge 3 dimensional star that I'm going to put over my lamp at school to make my form room look cool

Stu.1: Ahahaha that's awesome I never would have thought of doing that. How long have you been working on this piece?

Stu.2: Yea…it kinda just came to me when I was wokin on it in my room. I dunno how it is for you over there, but at my school these florescent lights are terrible.

Stu.1: Ahahahh believe me I know exactly what you're talking about.

Stu.2: But yea, I've been working on this for probably about 3 months. It just gets hard with school work sometimes, so I've had to put this on the back burner for awhile until I finally have enough free time to start up again.

Stu.1: Yeaaaaa school sucks ahahaha

Stu.2: But it seem like you know what your doing. Have you ever considered taking an art class to get better?

Stu.1: I've thought about it, but to be honest with you its kinda of just a hobby that I like to do that helps me relax and take my mind off things.

Stu.2: Yea I totally understand, it really does help you get your mind odd things because you constantly have to make sure your following the right directions and folding accurately.

Stu.1: Lately I've been experimenting with dollar bills

Stu.2: Ahaah what? Yea, you would be surprised how many different things you can make with a dollar bill.

Stu.1: Last week in class I was bored and fooling around and made a camera out of a dollar bill it was pretty sweet.

Stu.2: Whaaa that's crazy I don't think I would ever be able to do that.

Stu.1: Eghhh it wasn't that bad, plus my grandma showed me how to do it like a million times hahaha

Stu.2: Wow that's crazy.

Appendix 3

Student ID #_____

Instructions: To complete this survey, please rate each statement on its corresponding five-point scale. When you are finished, place it face down in the folder provided.

1) How would you rate your enjoyment?

1	2	3	4	5
Didn't enjoy at all		Moderately enjoyed		Enjoyed immensely

2) How would you rate your participation?

1	2	3	4	5
Didn't participate at all		Participated a bit		Participated a lot

3) How would you rate your interest?

1	2	3	4	5
Not interested at all		Moderately interested		Very interested

Appendix 4

ID #_____

Instructions: To complete this survey, please rate each statement on its corresponding five-point scale. When you are finished with the page, place it face down in the paper tray on your desk.

1.) How would you rate your experience in this experiment?

1	2	3	4	5
Didn't enjoy at all		Moderately enjoyed		Enjoyed immensely

2.) How upsetting (aversive) did you find this experiment to be?

1	2	3	4	5
Not upsetting at all		Moderately upsetting		Immensely upsetting

3.) Would you choose to participate in this experiment again?

1	2	3	4	5
Definitely no		Maybe		Definitely yes

4.) Would you recommend a friend to participate in this study?

1	2	3	4	5
Definitely no		Maybe		Definitely yes

5.) How much did this experiment replicate a real chat room experience?

1	2	3	4	5
Not at all like it		A little like it		Just like a real chat room

6.) Do you believe that the experimenters were completely honest with you?

1	2	3	4	5
Definitely no		Maybe		Definitely yes

7.) Did you ever at any time feel left out of the chat room?

1	2	3	4	5
Definitely no		Maybe		Definitely yes

8.) If you felt left out, to what degree did this rejection upset you?

1	2	3	4	5
Not at all		Moderately		A lot

9.) How angry did you become during the experiment?

1	2	3	4	5
Not at all		A little		A lot

Instructions: Please write the names of the two other students involved in the chat room and answer the following questions concerning the chat room experience.

1.) Student's name:_____

A.) How easy was it to communicate with this student?

1 2 3 4 5 6 7 8 9

Difficult Moderate Very easy

B.) Would you consider meeting this student?

1 2 3 4 5 6 7 8 9

No Maybe Yes

C.) How attractive was this student?

1 2 3 4 5 6 7 8 9

Unattractive Moderately attractive Very attractive

D.) How outgoing was this student?

1 2 3 4 5 6 7 8 9

Not at all Moderately outgoing Very outgoing

E.) How similar is this student to your normal group of friends?

1 2 3 4 5 6 7 8 9

Not at all Moderately similar Very similar

F.) How much do you have in common with this student?

1 2 3 4 5 6 7 8 9

Nothing Some things in common A lot

2.) Student's name:_____

A.) How easy was it to communicate with this student?

1 2 3 4 5 6 7 8 9

Difficult Moderately easy Very easy

B.) Would you consider meeting this student?

1 2 3 4 5 6 7 8 9

No Maybe Yes

C.) How attractive was this student?

1 2 3 4 5 6 7 8 9

Unattractive Moderately attractive Very attractive

D.) How outgoing was this student?

1 2 3 4 5 6 7 8 9

Not at all Moderately outgoing Very outgoing

E.) How similar is this student to your normal group of friends?

1 2 3 4 5 6 7 8 9

Not at all Moderately similar Very similar

F.) How much do you have in common with this student?

1 2 3 4 5 6 7 8 9

Nothing Some things in common A lot