The Psychological Effects of Ostracism Following Traumatic Brain Injury

Michelle Kelly[a], Skye McDonald[a] and David Kellett[b]

[a]School of Psychology, University of New South Wales, Sydney, Australia

[b]Hunter Brain Injury Service, Newcastle, Australia

Corresponding Author:
Dr Michelle Kelly
School of Psychology
University of New South Wales
Sydney, Australia, 2052
Michelle.Kelly@hnehealth.nsw.gov.au
PH: +61 423 972924
Co-authors:
Professor Skye McDonald
School of Psychology
University of New South Wales
Sydney, Australia, 2052
s.mcdonald@unsw.edu.au
PH: +61 2 9385 3029
FAX: +61 2 9385 3641
Dr David Kellett
Hunter Brain Injury Service
313 Darby Street, Bar Beach, NSW, Australia, 2300
David.Kellett@hnehealth.nsw.gov.au
PH: +61 2 49293100

Abstract

Primary Objective: This study examines the psychological effects of ostracism. It was predicted that adults with brain injury would have an attenuated response to an acute experience of ostracism.

Research Design: A within subject, fixed order design was used. The two conditions were ostracism and inclusion.

Methods and Procedures: A group of 20 adults with severe traumatic brain injury (TBI) were compared with a group of 19 matched control participants. Both groups participated in a pseudo online ball tossing game, Cyberball. On one occasion they were excluded from the game, and on the following occasion they were included fairly. Following each game they completed a self-report questionnaire about their experience.

Main Outcomes and Results: Persons with brain injury self-reported negative psychological effects of ostracism including a lower sense of belonging, self-esteem, and meaningful existence, however, were affected to a lesser degree than control participants [$F(1,37)=5.39$, $p=0.026$]. Persons with brain injury also reported that their feelings were hurt to a lesser extent than did control participants, $t(37)=2.10$, $p=0.04$.

Conclusions: These results are discussed in terms of the role of the negative experience of ostracism in motivating and guiding behaviour to re-establish group membership to prevent future social isolation.

Introduction

Social isolation or reduced social support is frequently reported as a consequence of brain injury [1-3]. Changes in social support are generally across the domains of family relationships, friendships, social activities and employment [4, 5]. Immediately following brain injury and during the acute recovery period, many patients have family and friends offering support and providing care. However, over time, and following long stints in hospital as well as in rehabilitation facilities, social supports dwindle [6], and continue to do so for the years following injury [7].

Individuals with TBI report loss of friendships and a reduction in social activities [8], and up to 62% reported that they had limited social contacts or were socially isolated up to 8 years after their brain injury [7]. These sorts of changes clearly affect overall quality of life for these individuals [9, 10]. It is, therefore, not surprising that people with a brain injury experience psychiatric disorders secondary to their injury [11, 12]. In fact, inadequate social support has been shown to be a significant predictor of depression following TBI [13]. Furthermore, a lower level of psychosocial functioning in those with a TBI has been linked to increased suicidal ideation [14].

While these links between self-reported changes in social support and psychological outcomes have been drawn, there is no evidence for the direct and immediate effects of ostracism, or an acute experience of social exclusion on individuals with brain injury. This is particularly important given that how a person reacts or copes with a single social experience may determine whether future opportunities for interactions are likely [see 15]. For example, if an individual enlists an undesirable response such as aggression [e.g. 16], future social interactions may be thwarted, and social isolation propagated as a result.

The effects of social exclusion, or ostracism (being ignored or excluded by one or more others), are difficult to assess in a real-life situation. Most research has relied on experimental paradigms where the experience of ostracism is induced within the research setting, and self-report measures taken soon after [e.g. 17, 18, 19]. This method ensures a controlled environment where the participant can be thoroughly debriefed following the experiment. One popular task for inducing ostracism in the laboratory is William's and colleagues Cyberball paradigm [20, also see 21]. This computerized game invites participants to play a game of toss over the internet with ostensibly real players. In reality, the other players are programmed by the experimenter to either include the real participant fairly for the course of the game, or exclude the real participant from play only after a few initial throws. Following the game the participant completes a questionnaire that examines the effects of each condition on mood as well as the Williams' hypothesized four fundamental human needs of self-esteem, belonging, meaningful-existence and control [20, 22].

Despite the artificial experience of social exclusion that occurs during the computer based task, the threat of the experience to social signals is so potent that after being ostracized for only a few minutes, adults, adolescents and children [23-25] alike report lower scores on mood measures [although not always, e.g. see 26 for discussion], markedly lowered sense of belonging, poorer self-esteem, reduced feelings of meaningful existence and less control [20, 27] (effect sizes are often, Cohen's *d*'s in the 1.0 to 2.0 range). These findings are consistent even when outgroup members or despised individuals are responsible for ostracizing the individual, therefore exemplifying the innate importance placed on group inclusion [15, 28].The strength of these findings using the Cyberball paradigm are now demonstrated in over 140 peer reviewed publications (see http://www1.psych.purdue.edu/~willia55/Announce/Cyberball_Articles.htm).

The initial reaction to ostracism in healthy adults is relatively well understood. Psychological discomfort such as low or negative mood, increased anxiety, physiological arousal [29], and hurt feelings are common. However, the processes that follow an experience of ostracism are less well understood. Williams' [30] proposes that people will attempt to employ coping strategies that will recoup or work toward attainment of the threatened needs (belonging, self-esteem, meaningful-existence and control). Strategies include cognitive, emotional and behavioural changes. For example, individuals might cognitively reframe the situation by reminding themself of other groups to which they belong [31], they may place importance on remembering socially relevant information [32], or they may conform to group norms [31]. Less socially desirable behavioural changes include becoming the aggressor in order to regain a sense of control over the situation [33].

While the psychological effects of ostracism are clear in the healthy adult population, the effect of ostracism, if any, are unknown in those with brain injury, despite the prevalence of social isolation in this population. Given the evidence that individuals with a brain injury subjectively report lower levels of arousal when it comes to emotionally laden stimuli, particularly negative stimuli [34, 35], it is unclear whether they will subjectively 'feel' the pain of ostracism to the same extent as healthy controls. Two-years following the injury, 54.7% of individuals reported a marked decline in their social network [36], and beyond 8 years post-injury 30-38% reported being lonely [37]. These findings suggest that on a whole, individuals with a brain injury are aware of social isolation to some degree. However, given the heterogeneity in the level of self-awareness across individuals with a traumatic brain injury [38], there may be a subgroup who are less aware of changes in their social circumstances. Failure to

recognise social exclusion may impede upon an individuals ability to engage in strategies that will increase the likelihood of future inclusion.

The current research aimed to determine the effects of ostracism on individuals with a TBI relative to matched controls. It was hypothesized that:

1) Both healthy controls and participants with a TBI would report lower levels of belonging, self-esteem, meaningful-existence and control following ostracism when compared to inclusion.
2) Both healthy controls and participants with a TBI would report their mood being more negative following ostracism compared with inclusion.
3) However, based upon related research demonstrating attenuated arousal to emotional stimuli in adults with a TBI, it was expected that the magnitude of the effect of ostracism would be less for the TBI group when compared to the control group. That is, that the TBI group would report a smaller difference on the fundamental needs and mood measures between the two conditions, than would control participants.

Methods

Participants

Participants in this study also completed a number of unrelated experimental tasks as part of a larger study.

Twenty adults (4 female and 16 male) between the ages of 19 and 66 years ($M = 45.65$, $SD = 15.46$) with severe TBI were recruited from local and regional brain injury rehabilitation and support services, including the Hunter Brain Injury Service and Headstart Community

Access Program (Newcastle, Australia). Participants were selected according to the following criteria: Severe TBI defined as having altered consciousness for greater than seven days [39]; living in the community; fluent English speakers; absence of aphasia or any hearing or sight impairments that would prevent them from participating in the experiments fully. Clinical information was obtained from hospital records and self-report. For those participants providing self-report only, additional information was gathered to determine the severity of the injury and to ensure that they did meet criteria for the study. Participant '4' reported a period of 28 days in a coma in addition to 9 weeks in a rehabilitation facility and he currently lives with his parents. Participant '12' reportedly spent 42 days in a coma, and a further 6 weeks in hospital before being transferred to a rehabilitation facility. He has not returned to work or driving and clearly had a significant depressed skull fracture. Participant '22' reportedly spent 4 weeks in hospital, lives with his mother, and has never worked. Participant '23' reportedly spent 6 weeks in rehabilitation, lives with her sister, has not returned to her occupation as a pathologist, and has not driven since her injury. Post-traumatic amnesia (PTA) ranged between 9 and 163 days (M = 73.13, SD = 49.51, $N = 16$) which was no different (one-sample t test, $p > 0.05$) from the mean length of PTA reported in a consecutive series of 100 people with TBI reported in an independent study [40]. All participants were tested a minimum of 8 months post injury (M = 89.80, SD = 109.60). The causes of brain injury with this sample were motor vehicle accidents (7), motor cycle accidents (3), falls (3), pedestrian vs. motor vehicle (3), assaults (3), and a sporting accident (1). Pathology on admission included penetrating injuries (1), skull fractures (8), cerebral oedema (2), extra and intracerebral haemorrhage (15), and cortical contusions (7). CT or MRI scans for were available for 11 participants, the remaining participants self-reported their injury details (see Table 1 for more detail).

The TBI group had achieved between 9 and 17 years of education (M = 13.08, SD = 2.77). Participants had been employed in occupations ranging from unskilled (3), to skilled trade or clerical (10), professional (2), managerial or business owner (3), and two students. Four participants had returned to their previous jobs, nine were currently unemployed, one was studying and the remaining six had taken less skilled jobs or volunteer work.

TABLE 1 ABOUT HERE

A group of 19 participants without a brain injury was recruited through the Hunter Medical Research Institute participant register, and through advertisements in local social and sporting clubs. This group comprised 13 males and 6 females aged between 25 and 64 years (M = 46.95, SD = 13.44). Formal education ranged between 11 and 16 years (M = 13.48, SD = 1.63). The control group was matched to the brain-injured group on the basis of age [t (38) = 0.28, p = 0.79], gender distribution (Pearson's χ_2 = 0.53, p = 0.47), and years of education [t (38) = 0.56, p = 0.58].

Participants in both the brain injured and the non-brain injured groups were excluded if they had a history of significant mental illness, substance abuse, learning disability, or any other neurological disorder (prior to the TBI for the clinical group). Participation was voluntary and informed consent was obtained in line with a protocol approved by the NSW Health Human Research Ethics Committee.

Design

The study used a within subject design with two conditions: ostracized first, followed by included. The order was fixed given that, (1) order was not shown to effect the self-reported outcomes of ostracism in normal healthy adults [see 29], (2) there was concern regarding the potential vulnerability of people with TBI to the repeated experience of social isolation.

A 2 (group) x 2 (condition) x 4 (needs) ANOVA was conducted to determine whether there were differences across conditions (Hypothesis 1) and whether this differed for the two groups (Hypothesis 3). Follow-up within groups ANOVAs were conducted to further address hypotheses 1 and 3. A 2 (group) x 2 (condition) x 8 (mood types) ANOVA addressed hypothesis 2, that mood would be detrimentally affected by ostracism, and again, whether this differed across groups (Hypothesis 3). Alpha was set at 0.05 unless otherwise specified.

Materials

1. Cyberball [20]

Participants were told they would be playing a game of 'toss' with other volunteers over the internet with the aim of *'investigating the effects of mental visualization'*. Participants played two versions of Cyberball: 1) exclusion condition, participants received four balls at the beginning of the game and were ignored thereafter (29 tosses); and 2) inclusion condition, throws were distributed evenly to all players throughout the game. Participants were not provided with the names of the other players, or their photos to avoid giving participants any other reason for disliking another player apart from that they were being ostracized by that person.

2. The Cyberball Questionnaire[1][other studies using this version are 25, 41, 42]

This questionnaire examined (1) the four fundamental needs (three questions per need), (2) current mood, and manipulation check. In total there were 24 questions. The responses were rated on a 5-point likert scale from 'not at all' to 'very much'. A 5-point likert scale was used to simplify the response options for people with cognitive impairment (9-point, 7-point, and 5-point scales have been used in the past with the Cyberball paradigm [e.g. 20, 25, 43] with no apparent effect on main outcomes [see 44, pg 29]). The fundamental needs questions were: *self-esteem* ("I felt good about myself", "I felt liked", "My self-esteem was high"), *sense of belonging* ("I felt disconnected", "I felt rejected", "I felt like an outsider"), *meaningful-existence* ("I felt non-existent", "I felt meaningless", "I felt invisible"), and *control* ("I felt I had control over the course of the interaction", "I felt powerful", "I felt superior"). The separate mood questions were: "My mood is"……. good, bad, happy, sad, friendly, unfriendly, tense, relaxed, "my feelings were hurt" and "I felt angry" (each rated on a 5-point likert scale). Four remaining questions examined the effectiveness of the manipulation, that is, how excluded or included participants felt: "I felt excluded" (likert scale), "I felt included" (likert scale), and, "Assuming 33% of the time you would receive the ball if everyone received it equally, what percent of the throws did you receive?". The final question thanked the participant and requested that they list any thoughts they had about the study, specifically requesting them to report whether they were suspicious or thought anything was strange about the game. This question gave participants the opportunity to express whether they questioned the authenticity of the social interaction. Responses were reverse scored as necessary.

[1] There are a number of different versions of the Cyberball post-experiment questionnaire (e.g. see [24, 33, 34, 36]). Despite the many slight variations in the questionnaire, for the majority of studies, the main outcomes are consistently observed. See reference [44], page 29 for statistics comparing two versions.

The questionnaires were computerized versions presented in Medialab (Empirisoft Corporation, Version 2008.1.33).

Procedure

Participants played the first Cyberball game (ostracism condition). They then completed the Cyberball Questionnaire. Participants completed a number of unrelated questionnaires before playing a second game of Cyberball (inclusion condition), followed by a repeated version of the Cyberball Questionnaire. Participants were then debriefed regarding the deceptive nature of Cyberball. Participants were instructed: *"In the upcoming experiment, we test the effects of practicing mental visualization on task performance. Thus, we need you to practice your mental visualization skills. We have found that the best way to do this is to have you play an on-line ball tossing game with other participants who are logged on at the same time. In a few moments, you will be playing a ball tossing game with other volunteers over our network. The game is very simple. When the ball is tossed to you, simply click on the LABEL of the player you want to throw it to. When the game is over, the experimenter will give you additional instructions. What is important is not your ball tossing performance, but that you MENTALLY visualize the entire experience. Imagine what the others look like. What sort of people are they? Where are you playing? Is it warm and sunny or cold and rainy? Create in your mind a complete mental picture of what might be going on if you were playing this game in real life.*
Okay, ready to begin? Please click 'Start' to begin."

Results

Manipulation Check

Participants in the control group accurately perceived the percentage of throws they received in the inclusion (actual = 33%; estimated $M = 37.53$, $SD = 3.90$) and ostracism (actual = 8%; estimated $M = 11.37$, $SD = 2.48$) conditions. One-sample *t*-tests revealed that control participants' reported percentage of balls received in each condition was not significantly different to the actual receipt of the ball [Inclusion, $t\ (18) = 1.16$, $p = 0.26$; Ostracism, $t\ (18) = 1.36$, $p = 0.19$]. Thus, the control participants were cognitively aware of their level of inclusion in the game. However, this was not the case for the TBI group whose estimated percentage of throws they received in the inclusion (actual = 33%; estimated $M = 43.65$, $SD = 4.68$) and ostracism (actual = 8%; estimated $M = 15.70$, $SD = 2.73$) conditions was significantly different to the actual receipt of balls [Inclusion, $t\ (19) = 2.27$, $p = 0.04$; Ostracism, $t\ (19) = 2.82$, $p = 0.01$]. While the TBI group was less accurate in their estimate of balls received in each condition, they still reported receiving less balls in the ostracism condition than in the inclusion condition [$t\ (19) = 4.80$, $p < 0.001$]. See Figure 1.

FIGURE 1 ABOUT HERE

In response to the question of whether there was anything suspicious about the game, 2 of the 19 control participants reported doubts over the reality of the game. None of the TBI group reported any suspicions.

Self-reported Levels of Fundamental Needs

The three questions assessing each fundamental need were evaluated for internal consistency. Cronbach's alpha coefficients for each need were: self-esteem = 0.84; belonging = 0.88; control = 0.72; and meaningful-existence = 0.87 which are consistent with previous studies [24, 45]. Given that the individual items for each of the four needs demonstrated adequate internal consistency, the items were averaged to form an overall score for self-esteem, belonging, control and meaningful-existence to be used in analyses.

A 2 (group) x 2 (condition) x 4 (needs) ANOVA revealed a significant main effect of condition [F (1, 37) = 62.29, $p < 0.001$]. In support of Hypothesis 1, participants across groups reported lower fulfilment of needs following ostracism when compared to inclusion. In addition there was a significant condition x needs interaction [F (3, 111) = 10.58, $p < 0.001$] suggesting that some needs were more affected by ostracism than others. Bonferroni corrected critical alpha ($\alpha/4 = 0.0125$) follow-up analyses suggested that each of the four needs were significantly affected by ostracism when examined alone (all p's < 0.001), however, belonging was significantly ($\alpha/6 = 0.008$) more affected by ostracism than meaningful-existence [t (38) = 3.30, $p = 0.002$], self-esteem [t (38) = 3.67, $p = 0.001$], and control [t (38) = 4.49, $p < 0.001$]. Of particular interest to this study, there was a significant group x condition interaction [F (1, 37) = 5.39, $p = 0.026$] suggesting that the TBI group responded to ostracism differently to the control group. Scores averaged across the four needs for the two groups in the inclusion and ostracism condition are depicted in Figure 2. Follow-up analyses for differences between the two conditions for the two groups separately demonstrated that both did experience a reduction in their self reported needs fulfilment as a result of the ostracism [Controls: t (18) = 6.54, $p < 0.001$; TBI: t (19) = 4.40, $p < 0.001$], however, the nature of the group x condition interaction is

revealed in Figure 2 where the lines (reflecting within group change) are not parallel. Thus, consistent with Hypothesis 3, this was a relatively smaller reduction for the people with TBI, i.e. the TBI group 'felt' the effects of ostracism to a lesser (M = 0.97, SD = 0.98) extent than the control group (M = 1.77, SD = 1.18).

FIGURE 2 ABOUT HERE

In order to determine whether this pattern held true across all needs, follow-up within group's analyses were conducted for each need individually. Using a Bonferroni adjusted critical alpha ($\alpha/4 = 0.0125$), participants in the **control** group reported significantly lower fulfilment levels in each of the four needs of belonging [t (18) = 9.30, $p < 0.001$], self-esteem [t (18) = 4.64, $p < 0.001$], control [t (18) = 4.04, $p = 0.001$], and meaningful-existence [t (18) = 5.85, $p < 0.001$] in the ostracism condition when compared to the inclusion condition (see Figure 3).

FIGURE 3 ABOUT HERE

Again, using a Bonferroni corrected critical alpha ($\alpha/4 = 0.0125$), participants in the **TBI** group reported significantly lower fulfilment levels in each of the needs belonging [t (19) = 3.98, $p = 0.001$], self-esteem [t (19) = 4.84, $p < 0.001$], and meaningful-existence [t (19) = 3.18, $p = 0.005$] in the ostracism condition when compared to the inclusion condition, with the exception of control [t (19) = 1.62, $p = 0.12$]. See Figure 4.

FIGURE 4 ABOUT HERE

Mood

Mood, as assessed by the Cyberball post-measure is presented for each group in Figure 5 and Figure 6. Those moods that can be characterized as "positive" (i.e. "good", "happy", "friendly", "relaxed") are shown on the left of the figure and those that can be categorized as "negative" (i.e. "bad", "unhappy", "sad", "tense") are depicted on the right. It would be anticipated that positive moods would decrease as a function of ostracism and negative moods increase. In order to depict this more clearly, Figure 7 shows the mean difference in positive and negative mood states (averaged across the four emotions in each category) in the ostracism condition relative to the inclusion condition. This suggests that both groups did show the anticipated change in mood although the TBI group appears to be more muted in their self-reported responses. This was not, however, supported statistically. A 2 (group) x 2 (condition) x 2 (valence) x 4 (mood) ANOVA *did not* reveal a significant group x condition interaction [F (1, 37) = 0.61, p = 0.44], although, in support of Hypothesis 2, it did reveal a significant condition x valence interaction [F (1, 37) = 26.51, $p < 0.001$].

FIGURE 5 ABOUT HERE

FIGURE 6 ABOUT HERE

FIGURE 7 ABOUT HERE

Finally, participants in both groups were asked how angry they were following each game, as well as how hurt their feelings were. There was no difference between groups in the extent to which their anger increased in the ostracism condition, however, the control group reported a greater level of 'hurt feelings' than did the TBI group, t (37) = 2.10, p = 0.04.

Discussion

Social and physical isolation following traumatic brain injury is common [46], and can potentially contribute to psychiatric illness [47]. A major contributor to such isolation may be the ability to monitor the evolving social environment and use the feedback to regulate behaviour to enhance social outcomes. Despite this, no research has utilized a controlled environment to examine the immediate impact social exclusion in individuals who have sustained a TBI. This study aimed to address this gap in the literature by investigating the impact of an acute experience of ostracism on the four fundamental needs of self-esteem, meaningful-existence, belonging, and control, as well as mood, in individuals with a brain injury.

In the first study to examine ostracism using the Cyberball paradigm in individuals with a TBI, both the control group and the TBI group were observed to be aware of their levels of inclusion or exclusion in each condition. While the control group was slightly more accurate in their estimate of inclusion than the TBI group, in the current study individuals with a TBI were aware when they were being excluded. This is consistent with studies of individuals with other clinical conditions, specifically Post-traumatic Stress Disorder [48] and Schizophrenia [49].

As predicted, both groups' reported needs were, generally, detrimentally affected by ostracism. The control group reported a lower sense of belonging, self-esteem, meaningful-existence and control following ostracism compared to when they were included, which is consistent with past research using this paradigm [27]. The TBI group displayed a similar pattern of response, that is, they reported experiencing a lower sense of belonging, self-esteem, and meaningful-existence following ostracism when compared with inclusion, however, this was not the case for their sense of control over the situation. Importantly, when

the groups were compared for the relative change in overall reported distress following ostracism versus inclusion, the TBI group were observed to be significantly *less* affected by ostracism than the control group.

These findings potentially pose both problems, and areas to focus interventions for individuals with a TBI. Provided that re-inclusion is a perceived possibility, the level of threat to needs may drive or direct the individual to endeavour to regain inclusion [30, 50]. If individuals with TBI are not experiencing this threat to the same degree as healthy controls, they may not be as motivated to strive for re-inclusion. Second, threats to belonging and self-esteem are known to motivate socially *favourable* strategies for regaining acceptance [50]. For example, they promote social attentiveness, such as mimicry [51], and memory for socially relevant information [32]. Furthermore, it has been demonstrated that rejected individuals are more accurate in detecting emotions from others' tone of voice and facial expression [18]. Therefore, the TBI groups' attenuated experience of threat may reduce their motivation to seek re-inclusion and their use of these compensatory strategies. Parenthetically, even if those with TBI are aware of their exclusion, they frequently have an impaired ability to both mimic [52] and recognize emotions in others [53] making it difficult to compensate in this manner. Threats to control and meaningful-existence are hypothesized to motivate less socially acceptable coping mechanisms such as becoming aggressive in order to re-establish control [33]. Therefore, the finding that control was not threatened when TBI participants were ostracized may actually be advantageous.

When examining the mood variables, both groups were negatively affected by the ostracism manipulation, that is, they reported their mood to be more negative after the experience of ostracism when compared to the experience of being included. Although a trend in the predicted direction was observed (see Figure 7), the two groups did not differ in the degree to which their mood was affected by ostracism. Clearer support of the hypotheses

was seen in the individual feelings question, following the ostracism condition, whereby those in the TBI group reported that their 'feelings were hurt' to a lesser degree than those in the control group.

While not consistent across all measures, the attenuated emotional experience observed here with regards to fundamental needs, mood and feelings is consistent with the commonly observed deficits in emotional experience after brain injury, such as apathy [54], reduced arousal to emotional stimuli [55] and impaired physiological activity when viewing emotional expressions [56]. While at face value it could be argued that *not* experiencing the normal effects to ostracism to their full extent could be an advantage, as mentioned, the negative consequences serve an important role in motivating and guiding behaviour to re-establish group membership [57], which is essential to maintaining a healthy sense of self and general wellbeing [31].

A potential limitation of the current study is the artificial nature of the Cyberball paradigm. Like with many experimental paradigms, claiming ecological validity is challenging. However, the paradigm has been extensively used and given the profound immediate effects demonstrated in this simple, computerized task, the effects in a real-life setting would have an even greater impact [for example 58]. A second limitation in the current study was that measures were taken immediately following the manipulation, which does not allow examination of the longer term effects of ostracism on this group. This may be of import as Perry et al. [49] demonstrated that the effects of ostracism last longer in individuals diagnosed with Schizophrenia. Finally, the construction of the questionnaire used in this study may introduce bias to individuals responses. However, as we are looking at group differences, and both groups were exposed to the same questionnaire, this is unlikely to change the main outcomes we examined.

There are a number of possible future directions for extending research into the acute experience of ostracism in those with a TBI. Research into what factors determine how one copes with or compensates for the negative experience of ostracism is beginning to be established in the healthy population, however, there are only a handful of studies on clinical groups, and no clinical studies looking at the predictors of coping strategies employed. While it has been demonstrated that threatening needs fulfilment is correlated with negative affect [44], it may be interesting to determine whether this effect would be different for individuals with brain injury. Given the cognitive and other social deficits observed in adults with a brain injury, future studies should allow for tailored interventions for this population. For example, those who are not impaired in mimicry may be able to engage in this as a socially attentive behaviour. Others who are impaired in the mimicry response may be taught how to regain inclusion using other methods such as enhanced cooperation [59], or conforming to the opinions of others [20].

Finally, the link between physiological responses and recognition of emotional states was drawn long ago by William James [see 60]. While researchers since this time have had difficulty drawing a direct relationship between physiological responses and self-reported distress [29], or emotion perception [52] they have certainly been able to show that individuals with a TBI for example, have impoverished physiological responses within the context of performing poorly on emotion recognition tasks [61]. Given the link between experiencing emotion and emotion perception [62], impoverished physiological responses may certainly provide clues as to why individuals with a TBI are not 'feeling' ostracism to the same extent as healthy control participants. Future research should examine this.

Declaration of Interest

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References

1. Jacobs, H.E., *The Los Angeles Head Injury Survey: procedures and initial findings.* Archives of Physical Medicine and Rehabilitation, 1988. **69**(6): p. 425-31.
2. Oddy, M. and M. Humphrey, *Social recovery during the year following severe head injury.* Journal of Neurology, Neurosurgery, and Psychiatry, 1980. **43**(9): p. 798-802.
3. Thomsen, I.V., *Late psychosocial outcome in severe traumatic brain injury. Preliminary results of a third follow-up study after 20 years.* Scandinavian Journal of Rehabilitation Medicine, 1992. **26**: p. 142-52.
4. Hawthorne, G., R.L. Gruen, and A.H. Kaye, *Traumatic brain injury and long-term quality of life: findings from an Australian study.* Journal of Neurotrauma, 2009. **26**(10): p. 1623-33.
5. Weddell, R., M. Oddy, and D. Jenkins, *Social adjustment after rehabilitation: a two year follow-up of patients with severe head injury.* Psychological Medicine, 1980. **10**(2): p. 257-63.
6. Kozloff, R., *Networks of social support and the outcome from severe head injury.* Journal of Head Trauma Rehabilitation, 1987. **2**: p. 14-23.
7. Tate, R.L., et al., *Psychosocial outcome for the survivors of severe blunt head injury: The results from a consecutive series of 100 patients.* Journal of Neurology, Neurosurgery, and Psychiatry, 1989. **52**: p. 1128-1134.

8. Annoni, J.M., S. Beer, and J. Kesselring, *Severe traumatic brain injury--epidemiology and outcome after 3 years.* Disability and rehabilitation, 1992. **14**(1): p. 23-6.

9. Corrigan, J.D., et al., *Life satisfaction after traumatic brain injury.* The Journal of Head Trauma Rehabilitation, 2001. **16**(6): p. 543-55.

10. O'Neill, J., et al., *The effect of employment on quality of life and community integration after traumatic brain injury.* The Journal of Head Trauma Rehabilitation, 1998. **13**(4): p. 68-79.

11. Hesdorffer, D.C., S.L. Rauch, and C.A. Tamminga, *Long-term psychiatric outcomes following traumatic brain injury: a review of the literature.* The Journal of Head Trauma Rehabilitation, 2009. **24**(6): p. 452-9.

12. Gould, K.R., et al., *The nature, frequency and course of psychiatric disorders in the first year after traumatic brain injury: a prospective study.* Psychological Medicine, 2011. **41**(10): p. 2099-109.

13. Douglas, J.M. and F.J. Spellacy, *Correlates of depression in adults with severe traumatic brain injury and their carers.* Brain Injury, 2000. **14**(1): p. 71-88.

14. Tsaousides, T., J.B. Cantor, and W.A. Gordon, *Suicidal ideation following traumatic brain injury: prevalence rates and correlates in adults living in the community.* The Journal of head trauma rehabilitation, 2011. **26**(4): p. 265-75.

15. Williams, K.D., *Ostracism.* Annual Review of Psychology, 2007. **58**: p. 425-452.

16. Buckley, K.E., R.E. Winkel, and M.R. Leary, *Reactions to acceptance and rejection: effects of level and sequence of relational evaluation.* Journal of Experimental Social Psychology, 2004. **40**: p. 14-28.

17. Nezlek, J.B., et al., *Personality moderators of reactions to interpersonal rejection: depression and trait self-esteem.* Personality and Social Psychology Bulletin, 1997. **23**(12): p. 1235-1244.

18. Pickett, C.L., W.L. Gardner, and M. Knowles, *Getting a cue: the need to belong and enhanced sensitivity to social cues.* Personality and Social Psychology Bulletin, 2004. **30**(9): p. 1095-1107.

19. Williams, K.D. and K.L. Sommer, *Social ostracism by coworkers: Does rejection lead to loafing or compensation?* Personality and Social Psychology Bulletin, 1997. **23**(7): p. 693-706.

20. Williams, K.D., C.K.T. Cheung, and W. Choi, *Cyberostracism: effects of being ignored over the internet.* Journal of Personality & Social Psychology, 2000. **79**(5): p. 748-762.

21. Williams, K.D. and B. Jarvis, *Cyberball: a program for use in research on interpersonal ostracism and acceptance.* Behavior Research Methods, 2006. **38**(1): p. 174-80.

22. Williams, K.D. and L. Zadro, *Ostracism: The Indiscriminate Early Detection System.*, in *The social outcast: Ostracism, social exclusion, rejection, and bullying*, K.D. Williams, J.P. Forgas, and W. von Hippel, Editors. 2005, Psychology Press: New York. p. 19-34.

23. Sebastian, C., et al., *Social brain development and the affective consequences of ostracism in adolescence.* Brain and Cognition, 2010. **72**(1): p. 134-45.

24. Lau, G., M.L. Moulds, and R. Richardson, *Ostracism: How Much It Hurts Depends on How You Remember It.* Emotion, 2009. **9**(3): p. 430-434.

25. Zadro, L., C. Boland, and R. Richardson, *How long does it last? The persistence of the effects of ostracism in the socially anxious.* Journal of Experimental Social Psychology, 2006. **42**(5): p. 692-697.

26. Baumeister, R.F., et al., *Thwarting the Need to Belong: Understanding the Interpersonal and Inner Effects of Social Exclusion.* Social and Personality Psychology Compass, 2007. **1**: p. 506-520.

27. Zadro, L., K.D. Williams, and R. Richardson, *How low can you go? ostracism by a computer is sufficient to lower self-reported levels of belonging, control, self-esteem, and meaningful existence.* Journal of Experimental Social Psychology, 2004. **40**(4): p. 560-567.

28. Gonsalkorale, K. and K.D. Williams, *The KKK won't let me play: ostracism even by a despised outgroup hurts.* European Journal of Social Psychology, 2007. **37**(6): p. 1176-1186.

29. Kelly, M., S. McDonald, and J. Rushby, *All alone with sweaty palms — Physiological arousal and ostracism.* International Journal of Psychophysiology, 2012. **83**: p. 309-314.

30. Williams, K.D., *Social ostracism*, in *Aversive Interpersonal Behaviors*, R. Kowalski, Editor 1997, Plenum: New York. p. 133-170.

31. Baumeister, R.F. and M.R. Leary, *The need to belong: desire for interpersonal attachments as a fundamental human motivation.* Psychological Bulletin, 1995. **117**(3): p. 497-529.

32. Gardner, W.L., C.L. Pickett, and M.B. Brewer, *Social exclusion and selective memory: How the need to belong influences memory for social events.* Personality and Social Psychology Bulletin, 2000. **26**: p. 486-496.

33. Warburton, W.A., K.D. Williams, and D.R. Cairns, *When ostracism leads to aggression: The moderating effects of control deprivation.* Journal of Experimental Social Psychology, 2006. **42**: p. 213–220.

34. Saunders, J.C., S. McDonald, and R. Richardson, *Loss of emotional experience after traumatic brain injury: findings with the startle probe procedure.* Neuropsychology, 2006. **20**(2): p. 224-31.

35. de Sousa, A., et al., *Why don't you feel how I feel? Insight into the absence of empathy after severe traumatic brain injury.* Neuropsychologia, 2010. **48**(12): p. 3585-95.

36. Finset, A., et al., *Self-reported social networks and interpersonal support 2 years after severe traumatic brain injury.* Brain injury, 1995. **9**(2): p. 141-50.

37. Colantonio, A., et al., *Gender differences in self reported long term outcomes following moderate to severe traumatic brain injury.* BMC Neurology, 2010. **10**: p. 102.

38. Sherer, M., et al., *Characteristics of impaired awareness after traumatic brain injury.* Journal of the International Neuropsychological Society, 1998. **4**(4): p. 380-7.

39. Williamson, J.G., J.G. Scott, and R.L. Adams, *Traumatic Brain Injury,* in *Neuropsychology for Clinical Practice: Etiology, Assessment, and Treatment of Common Neurological Disorders,* R.L. Adams, et al., Editors. 1996, American Psychological Association: Washington DC.

40. Tate, R.L., G.A. Broe, and J.M. Lulham, *Impairment after severe blunt head injury: The results from a consecutive series of 100 patients.* Acta Neurologica Scandinavia, 1989. **79**(97-107).

41. Ruggieri, S., et al., *Cyberball: The impact of ostracism on the well-being of early adolescents.* Swiss Journal of Psychology, 2013. **72**(2): p. 103-109.

42. Sethi, N., M.L. Moulds, and R. Richardson, *The role of focus of attention and reappraisal in prolonging the negative effects of ostracism* Group Dynamics: Theory, Research, and Practice, 2013. **17**(2): p. 110-123.

43. Jamieson, J.P., S.G. Harkins, and K.D. Williams, *Need threat can motivate performance after ostracism.* Personality and Social Psychology Bulletin, 2010. **36**(5): p. 690-702.

44. Waldrip, A.M., *The power of ostracism: can personality influence reactions to social exclusion?* , in *Faculty of The Graduate School*2007, The University of Texas: Arlington.

45. van Beest, I. and K.D. Williams, *When inclusion costs and ostracism pays, ostracism still hurts.* Journal of Personality & Social Psychology, 2006. **91**(5): p. 918-928.

46. Sander, A.M. and M.A. Struchen, *Interpersonal relationships and traumatic brain injury.* The Journal of Head Trauma Rehabilitation, 2011. **26**(1): p. 1-3.

47. Gould, K.R., et al., *Relationship between psychiatric disorders and 1-year psychosocial outcome following traumatic brain injury.* The Journal of head trauma rehabilitation, 2011. **26**(1): p. 79-89.

48. Nietlisbach, G. and A. Maercker, *Effects of Social Exclusion in Trauma Survivors With Posttraumatic Stress Disorder.* Psychological Trauma: Theory, Research, Practice, & Policy, 2009. **1**(4): p. 323-331.

49. Perry, Y., et al., *The pain persists: how social exclusion affects individuals with schizophrenia.* The British Journal of Clinical Psychology, 2011. **50**(4): p. 339-49.

50. Williams, K.D., *Chapter 6 Ostracism: a temporal need-threat model.* Advances in Experimental Social Psychology, 2009. **Volume 41**: p. 275-314.

51. Lakin, J.L. and T.L. Chartrand, *Using nonconscious behavioral mimicry to create affiliation and rapport.* Psychological Science, 2003. **14**(4): p. 334-9.

52. McDonald, S., et al., *Impaired mimicry response to angry faces following severe traumatic brain injury.* Journal of Clinical and Experimental Neuropsychology, 2011. **33**(1): p. 17-29.

53. McDonald, S. and S. Flanagan, *Social perception deficits after traumatic brain injury: interaction between emotion recognition, mentalizing ability, and social communication.* Neuropsychology, 2004. **18**(3): p. 572-9.

54. Kant, R., J.D. Duffy, and A. Pivovarnik, *Prevalence of apathy following head injury.* Brain injury, 1998. **12**(1): p. 87-92.

55. Sanchez-Navarro, J.P., J.M. Martinez-Selva, and F. Roman, *Emotional response in patients with frontal brain damage: effects of affective valence and information content.* Behavioral Neuroscience, 2005. **119**(1): p. 87-97.

56. Hopkins, M.J., J. Dywan, and S.J. Segalowitz, *Altered electrodermal response to facial expression after closed head injury.* Brain Injury, 2002. **16**(3): p. 245-57.

57. Williams, K.D. and S.A. Nida, *Ostracism: Consequences and coping.* Current Directions in Psychological Science, 2011. **20**(2): p. 71-75.

58. Leary, M.R., et al., *Teasing, rejection, and violence: case studies of the school shootings.* Aggressive Behavior, 2003. **29**(3): p. 202-214.

59. Ouwerkerk, J.W., et al., *Avoiding the social death penalty: Ostracism and cooperation in social dilemmas*, in *The social outcast: Ostracism, social exclusion, rejection, and bullying*, K.D. Williams and W. vonHippel, Editors. 2005, Psychology Press: New York. p. 321-332.

60. Watson, R.I., *The Great Psychologists.*1978, New York: J. B. Lippincott and Co.

61. McDonald, S., et al., *The influence of attention and arousal on emotion perception in adults with severe traumatic brain injury.* International Journal of Psychophysiology, 2011. **82**(1): p. 124-131.

62. Phillips, M.L., et al., *Neurobiology of emotion perception I: The neural basis of normal emotion perception.* Biological Psychiatry, 2003. **54**(5): p. 504-14.

Table 1. *Injury characteristics of TBI participants*

Id.	Age	Gender	Time Post Injury (months)	PTA (days)	Cause	Injury Location	Injury Description
1	41	Male	8	63	MCA	L+R parietal, R temporal, R occipital, DAI	Cortical contusions
2	25	Male	17	75	Assault	L+R frontal, R parietal, L+R temporal, DAI	Skull fracture, petechial haemorrhage, subarachnoid haemorrhage, subdural haematoma, subgaleal haematoma, contusions, cerebral oedema
3	48	Female	47	150	MVA	L frontal, L+R temporal, L occipital, DAI	Skull fracture, subarachnoid haemorrhage, subcutaneous haematoma, subdural hygroma, contusions
4	39	Male	33	28+	MVA	na	na
5	66	Male	19	9	MVP	L frontal, DAI	Petechial haemorrhage, subdural haematoma
7	58	Male	29	56	MCA	L+R frontal, DAI	Skull fracture, subdural haematoma
9	24	Male	38	163	MVA	L+R frontal, L+R parietal, R temporal, DAI, midline shift	Skull fracture, Petechial haemorrhage, subarachnoid haemorrhage, subdural haematoma, contusions, cerebral oedema
11	58	Male	18	14	Fall	L frontal, L temporal, R occipital	Skull fracture, subarachnoid haemorrhage, subdural haematoma, subcutaneous haemorrhage, contusions
12	51	Male	312	42+	MVP	R frontal, R temporal	Skull fracture
13	27	Male	18	30	Assault	L temporal	Skull fracture
14	61	Male	43	10	Fall?	na	na
15	59	Male	12	35	Fall	R frontal, L+R temporal	Skull fracture, subdural haematoma, contusions
16	32	Male	14	60	MCA	L+R frontal, L temporal, DAI	Petechial haemorrhage
18	30	Female	72	140	MVA	L+R frontal, R parietal, R temporal, R occipital, DAI	Petechial haemorrhage, subarachnoid haemorrhage, subdural haematoma, contusions
20	19	Female	16	65	MVA	na	na
22	40	Male	324	na	Sport	L+R frontal	na
23	65	Female	158	na	MVA	R frontal	na
24	64	Male	294	90	MVA	R frontal	Subarachnoid haemorrhage, intracerebral haematoma
25	59	Male	228	120	MVP	R frontal	Intracerebral haematoma
26	47	Male	96	90	Assault	L+R frontal	Subdural haematoma

Note. MVA = motor vehicle accident; MCA = motor cycle accident; MVP = motor vehicle versus pedestrian; na = not available; DAI = diffuse axonal injury; L = left; R = right.

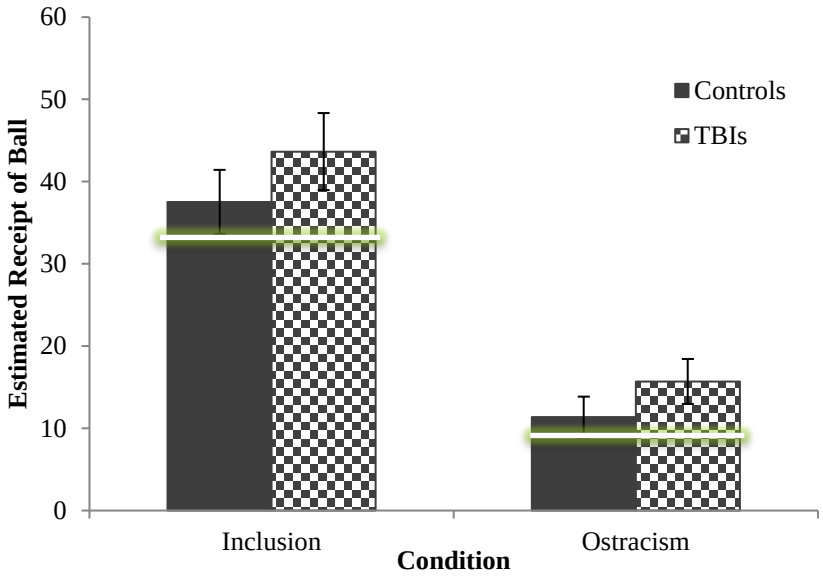

Figure 1. Mean (SE) estimated percentage receipt of the ball during the inclusion and ostracism conditions for the control group and the TBI group. The line on each column indicates the actual receipt of the ball in that condition.

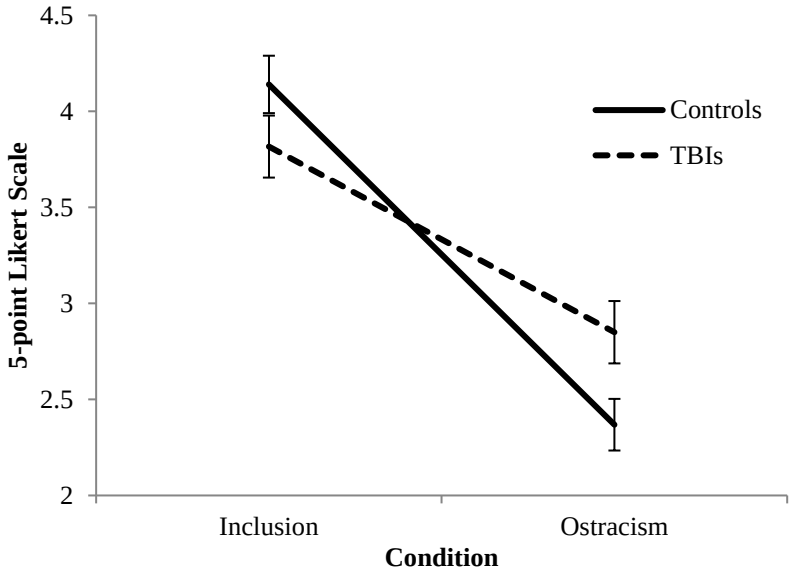

Figure 2. Mean (SE) overall fundamental needs for the control group and for the TBI group during the ostracism and inclusion conditions.

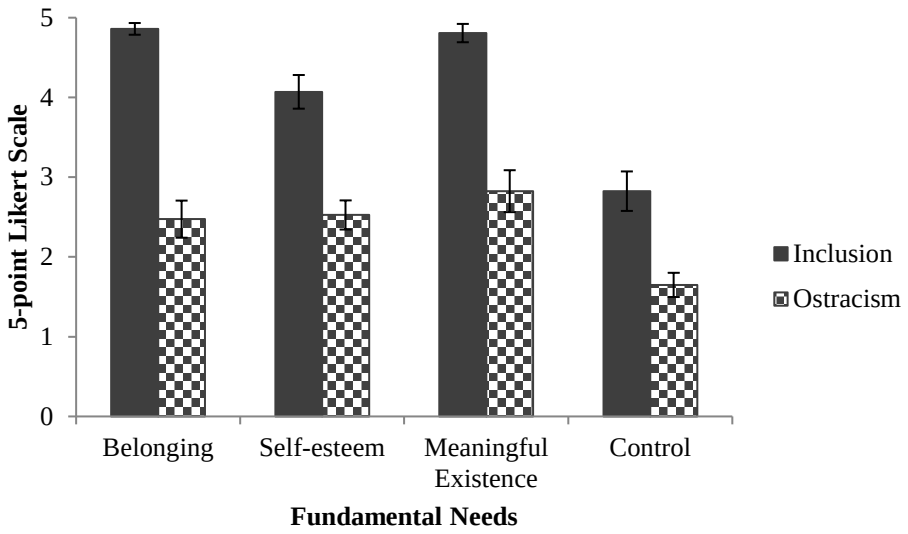

Figure 3. Mean (SE) self-reported levels of needs of belonging, self-esteem, control and meaningful-existence for the **control** group during the ostracism and inclusion conditions.

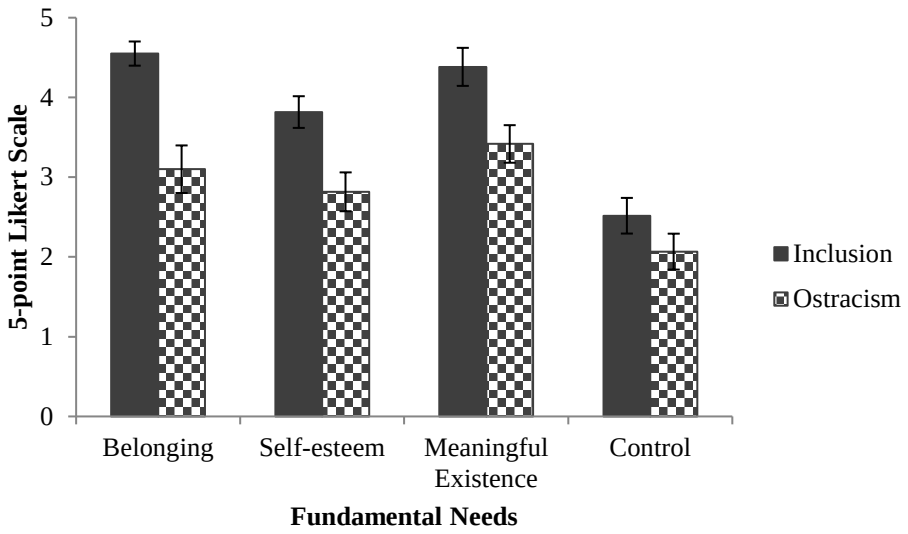

Figure 4. Mean (SE) self-reported levels of needs of belonging, self-esteem, control and meaningful-existence for the **TBI** group during the ostracism and inclusion conditions.

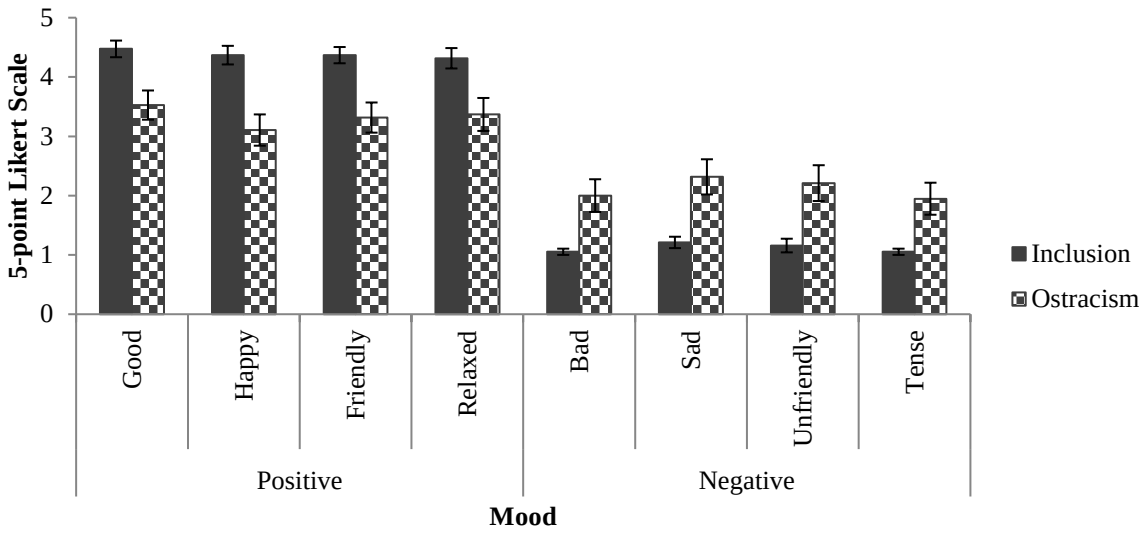

Figure 5. Mean (SE) self-reported mood when the **control** group were ostracized versus when they were included.

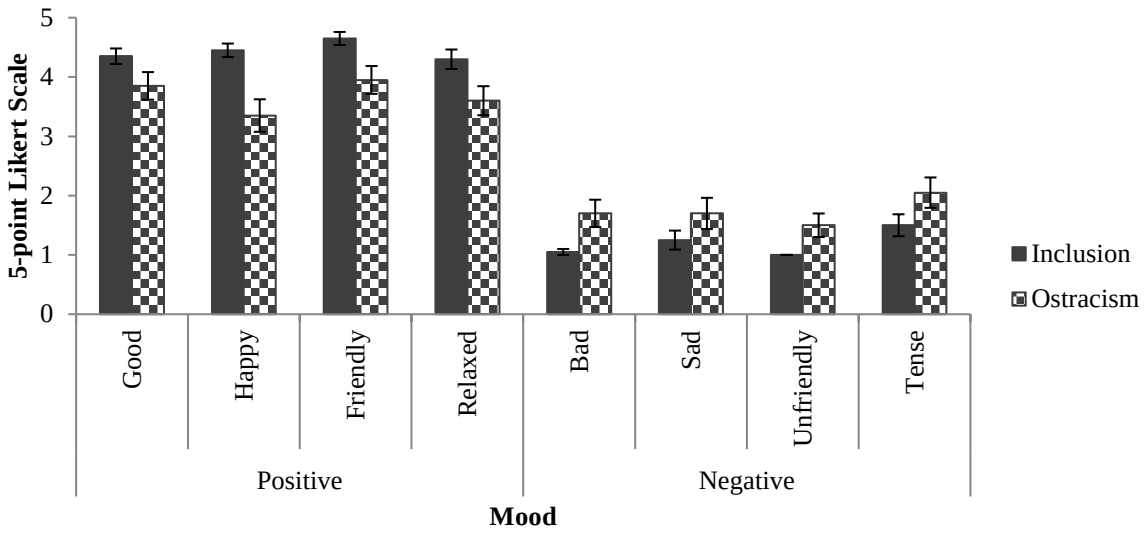

Figure 6. Mean (SE) self-reported mood when the **TBI** group were ostracized versus when they were included.

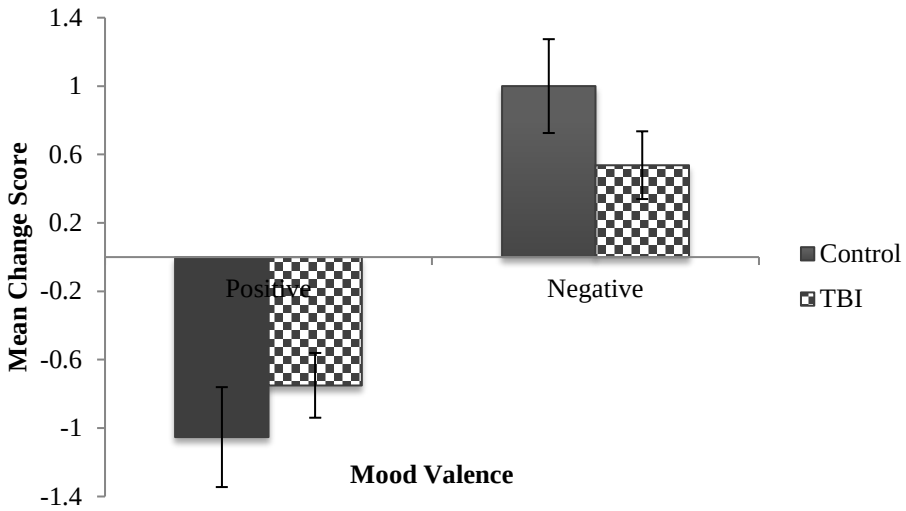

Figure 7. Mean (SE) difference in scores for positive and negative mood in the ostracism condition relative to the inclusion condition for the control group and the TBI group.

Figure Captions

Figure 1. Mean (SE) estimated percentage receipt of the ball during the inclusion and ostracism conditions for the control group and the TBI group. The line on each column indicates the actual receipt of the ball in that condition.

Figure 2. Mean (SE) overall fundamental needs for the control group and for the TBI group during the ostracism and inclusion conditions.

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