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BRIEF REPORT

To be spurned no more: The affective and behavioral consequences of social and nonsocial rejection

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Abstract Social pain is often associated with social rejection and shares neural correlates with the bothersome aspect of physical pain, which may also indicate an overlap in function. Pain has been described as a motivational signal to respond to the source of the pain in an adaptive way, such as by altering behavior. We tested whether social pain causes similarly adaptive alterations in behavior. Participants played computerized ball-tossing tasks with putative players—one who passed to and one who excluded the participant from play—in both a social and nonsocial version. We assessed the behavioral consequences of social pain by comparing the number of throws to each stimulus (social rejector vs. nonsocial rejector) over the course of the task. Posttask questionnaires assessed subjective feelings of social pain. A decrease in throws to the rejecting stimulus was only observed in the social version, indicating that rejection that is social in nature leads to change in behavior. Moreover, participants reported more negative feelings toward the rejecting stimulus in the social than in the nonsocial version. These subjective feelings of social pain mediated the effect of version of the game (social vs. nonsocial) on changes in behavior, indicating that social pain from social rejection causes changes in behavior.

Keywords Social cognition · Learning · Decision making

The experience of physical pain is comprised of an affective component and a sensory component (Rainville, Duncan, Price, Carrier, & Bushnell, 1997). The sensory component, with neural substrates in the somatosensory cortex, is the component that reflects actual or impending physical damage. The affective component, with substrates in the dorsal anterior cingulate cortex (dACC) and anterior insula (AI), concerns the distressing or bothersome aspects of physical pain (Rainville et al., 1997).

Recent neuroimaging data show that the same areas associated with the bothersome affective component of physical pain (dACC and AI) are also activated during the experience of social pain, which is often associated with social rejection or exclusion (Eisenberger, Lieberman, & Williams, 2003). Although a complete understanding of the commonalities and differences among neural correlates of physical and social pain may be more complex than originally thought (e.g., Cacioppo et al., 2013), the general sensitivity of areas, such as the dACC and AI, to social as well as physical pain may have important adaptive implications.

For example, just as there is an overlap in neural origins there may likewise be an overlap in the functional significance of physical and social pain. Specifically, the affective bothersome aspect of pain—regardless of how it is triggered— may act as a signal that one needs to modify one's behavior. Indeed, people with lesions of the dACC report that they can sense pain, but that it is not bothersome, which is problematic for learning appropriate escape or protective responses (Berthier, Starkstein, & Leiguarda, 1988; Foltz & White, 1962). The unpleasant aspects of pain can therefore be understood as providing a motivational signal to respond to the source of the pain in an adaptive way (Craig, 2003), whether by stopping or altering the behavior that immediately preceded the onset of the pain or by otherwise prioritizing the processing of alternatives to the source of pain. By helping to control and modify behavior, pain may therefore also be viewed as a critical mechanism of cognitive control for

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successfully pursuing goals and behaving adaptively (Shenhav, Botvinick, & Cohen, 2013).

In our evolutionary past, not being part of a group meant elevated vulnerability to the surrounding environment, food scarcity, and decreased likelihood of survival. Being part of a social group and avoiding rejection would therefore be an adaptive goal. Perhaps this evolutionary backdrop explains why humans have come to value inclusion and feel pain from rejection (MacDonald & Leary, 2005); social pain should motivate people to cease the behaviors that led to social exclusion.

Recent advances in revealing the underlying mechanisms of these social emotions have focused on the pain caused by social rejection, ostracism, or exclusion, as well as the neural correlates associated with social rejection (e.g., Eisenberger et al., 2003). Kawamoto and colleagues (2012), for instance, measured fMRI signals in the brains of participants as they played a virtual ball-tossing game in which they were included or excluded. The previously established link between social pain and dACC activity (e.g., Eisenberger et al., 2003) was again reflected here, with participants showing relatively greater activation of the dACC and self-reported feelings of social pain during the periods of social exclusion than during the periods of inclusion (Kawamoto et al., 2012). Krill and Platek (2009) have likewise shown that social-exclusion-related dACC activity is greater when a participant is rejected by in-group than by out-group members, suggesting a possible mechanism to ensure we stay connected to those individuals most likely to help with our survival. However, although such studies are informative about the factors that elicit social pain and its neural underpinnings, they provide little evidence about its actual impact on subsequent behavior. We address this void here.

Given what we know about the neurological underpinnings and adaptive significance of social pain, the overarching hypothesis of this study is that the function of physical and social pain is similar. Functionally, acute physical pain can aid in learning which objects and situations are considered harmful and are best avoided (Craig, 2003). Similarly, social pain may help us to change our behavior by learning which groups of people, specific people, or social situations may be harmful so that priority is given to those who are less likely to exclude or otherwise interfere with an individual's goal-directed efforts.

Cyberball

Cyberball is a widely used way to study feelings of ostracism, rejection, and exclusion (Williams, Cheung, & Choi, 2000). A group of two or three putative players are displayed on a computer screen and take part in a game of catch with the participant, who is also represented by a virtual avatar. Although the participant is led to believe the other "players" are real, each player can be programmed by the researcher to pass the ball to the participant as frequently or infrequently as needed to create situations of social inclusion or exclusion.

Many studies have shown that participants subsequently self-report greater negative affect as a result of being excluded during Cyberball games, including feelings of decreased belonging (e.g., Zadro, Williams, & Richardson, 2004). Social exclusion induced by Cyberball has led participants to feel increased amounts of anger and to engage in more antisocial behaviors, such as choosing an unappealing snack for other "participants" (Chow, Tiedens, & Govan, 2008). Some other studies have explored the effect of social exclusion from Cyberball on an additional task or measure of antisocial behavior (e.g., Dewall, Twenge, Gitter, & Baumeister, 2009). These experiments have considered ways in which individuals respond to being socially rejected by assessing their behavior in an additional task. In contrast, this study explores the immediate impact of rejection on behavior during Cyberball. If the function of social pain is similar to that of physical pain, social rejection should provide an affective signal to modify behavior during the task.

Furthermore, most previous research has focused on the differences in feelings of social pain from being excluded versus being included at a global level. Usually, all purported players either include or exclude the participant. This study aims to explore the specificity of these feelings of exclusion by measuring the participant's behavioral and affective responses to one rejecting player by directly comparing behavior and subjective feelings toward another inclusive player.

Finally, this study aims to explore whether the impacts of rejection depend solely on the social nature of the game. Previous research found that even when participants were told that they were playing Cyberball with computer-generated players, they still expressed greater feelings of social pain after being excluded than when they were included in the game (Zadro et al., 2004); however, these researchers still used the same human-like avatars to represent other "players," so it was not totally devoid of a social context. This study includes a new version of the Cyberball game that was designed to be completely nonsocial to adequately assess if the implications of Cyberball are truly social in nature.

Present study

This study seeks to explore how individuals learn from the experience of negative affect generated through social rejection; what are the behavioral consequences of pain triggered by social interactions? It is hypothesized that rejection will lead to the experience of social pain, that this social pain will be specific to the rejecting stimulus, and that the specificity of this painful state will lead to avoidance of the source of the pain. Specifically, if the rejecting stimulus elicits negative

affect, as shown in previous studies, then participants should respond to this affective signal by engaging less often with the rejecting stimulus. This behavioral avoidance is also expected to be specific to the rejecting stimulus and to only occur in the social version of Cyberball when the rejecting stimulus is perceived to be a social agent (i.e., another person). The same level of social distress and behavioral avoidance of the rejecting stimulus is not expected to occur during the nonsocial version when the rejecting stimulus is clearly not a social agent.

Method

Participants

One hundred and ninety-three undergraduate students participated in the experiment at the University of Guelph. A total of 32 participants were removed from analysis. Eight were removed because of technical difficulties and 24 because they failed a manipulation check that assessed the extent to which participants in the social version believed they were actually playing the virtual ball-tossing game with other participants in the lab. This resulted in a sample size of 161 undergraduate students: 80 males and 81 females (18.75 years ± 1.46 years). Sample size was determined using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007), with the appropriate information based on the results from similar studies (Hess & Pickett, 2010; Zadro et al., 2004). Experiment-related differences in rejection-related variables, such as mood and self-esteem, had effect sizes of approximately d = .80. Our initial analysis revealed that we would therefore need a sample size of approximately 80 to find similar-sized effects. We opted instead to double this number in anticipation of the possibility that our effects of interest—the affective and behavioral consequences of being both rejected and not rejected by different (social and nonsocial) agents within the same session–could be somewhat smaller in magnitude than those previously examined.

Participants were recruited using posters around campus and the undergraduate Psychology Participant Pool. Participants were given course credit or compensated $10 per hour, depending on their method of recruitment. The Research Ethics Board at the University of Guelph approved all methods and procedures. All participants provided informed consent.

Stimuli and apparatus

Macintosh computers with 17-in. monitors were used for stimulus presentation and data collection. The experiment used Cyberball Version 4.0 (Williams, Yeager, Cheung, & Choi, 2012), which runs in a browser using HTML5, and a nonsocial version of Cyberball in which participants interacted with pipes. The schedule of ball tossing had two distinct portions: a "fair-play" portion, in which the players/pipes returned the ball to participants 50 % of the time, and an "experimental" portion, in which one of the players/pipes never returned the ball to participants whereas the other player/pipe continued to return the ball 50 % of the time. The purpose of the fair-play portion was to get participants accustomed to the program and to have a neutral, realistic exposure to the other players/pipes. The transition from the fair-play to experimental portion of the program was seamless to participants and occurred after they had received a total of three throws from each of the players/pipes.

Design and procedure

Social version Participants were told that they were going to play an interactive ball-tossing game with two other participants. They were asked to visualize playing a game of catch as if it were happening in real life and told that the experiment was investigating mental visualization and decision making. Human-like avatars represented the players (see Fig. 1).

The game lasted approximately 8 minutes and included a total of 115 throws, with the participants required to make a minimum of 21 and a maximum of 26 decisions regarding which player to pass the ball to during the experimental phase. The total number of decisions made was dependent on previous decisions made during the game. We recorded these decisions and analyzed them further to see if there was a change in throwing behavior over time. We counterbalanced the gender of the rejecting player as indicated by the player's name (Jenny and Paul), as well as the side of the screen on which the rejecting player was represented.

Nonsocial version Participants were told that they were going to be participating in a computer game involving a network of pipes. They were told that they were part of an experiment assessing visualization and decision making and that they were to visualize the network of pipes and decide which pipe to send the ball to (see Fig. 1). In this version, any words insinuating agency on behalf of the pipes were eliminated from the instructions. This included omitting any descriptions that likened the task to a "game of catch." Pipes were used instead of the human avatars in the social version. The pipes were given labels of *Pipe 1* and *Pipe 2* instead of names. Aside from the images used and instructions given, all other settings and procedures were identical to the social version.

Questionnaires and debriefing After both versions of the task, participants were given questionnaires to record demographic information and assess subjective feelings. A manipulation check was used in the social condition in which participants were asked, "Did it feel like you were interacting with other participants in the lab?" This check assessed

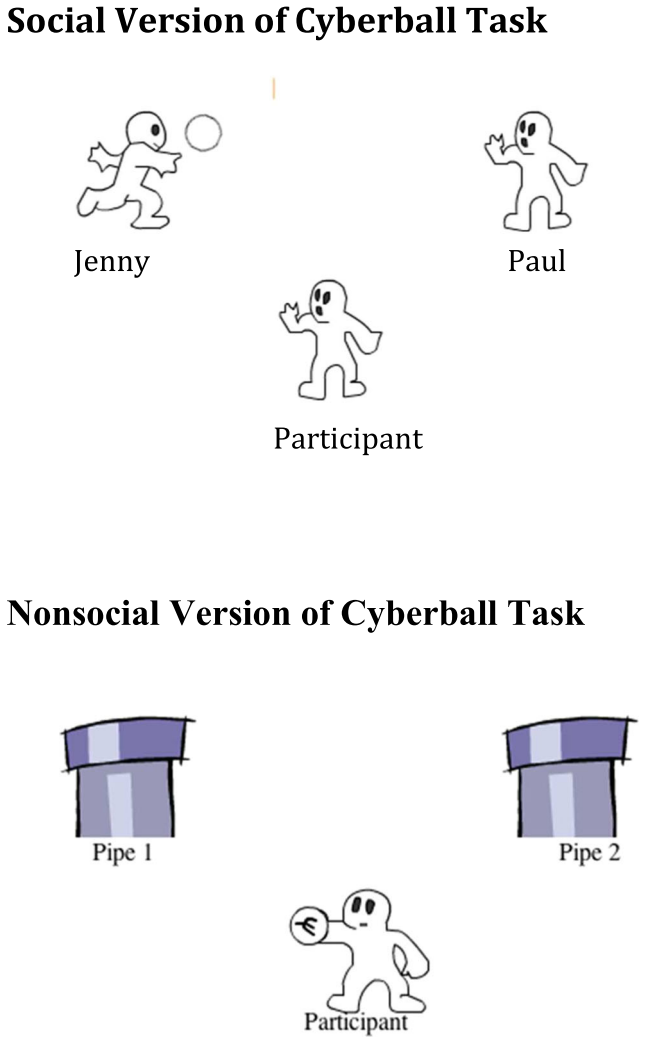


Fig. 1 Social and nonsocial versions of the Cyberball task

whether participants believed that they were playing with other participants. If they reported that they had guessed the other participants were not real or that they were being told what to do by the experimenter, their data were excluded from further analyses. Participants were fully debriefed regarding the true purpose of the experiment and the need for the use of deception.

Measures

Behavior The Cyberball program recorded participants' decisions regarding which player/pipe to throw the ball to. These decisions were analyzed to derive the proportion of throws that were sent to the rejecting player/pipe over time. Specifically, we compared the relative proportion of tosses within the first 10 throws of the experimental phase to the proportion within the last 10 throws of that phase; this comparison allows an assessment of any overall change in throwing behavior over the course of the game. The minimum number of throws for any participant was 21 (maximum, 26). Therefore, comparing the first 10 throws to the last 10 throws allowed for the same maximum number of throws to be included in the analyses for every participant.

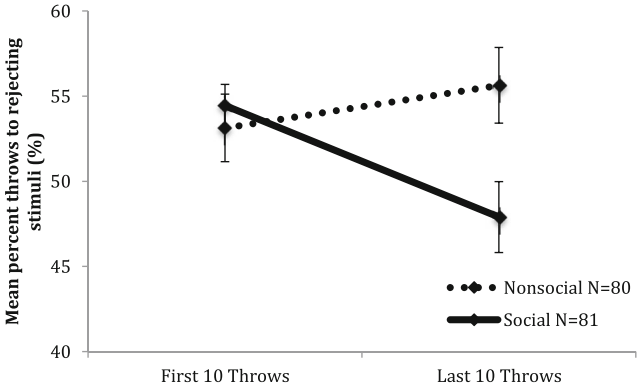
Specific subjective feelings questionnaire Differences in subjective feelings were measured using a posttask self-report questionnaire. This questionnaire was derived from prior research on the effects of social rejection (Hess & Pickett, 2010; Williams et al., 2000). The items were presented on 9-point Likert scales. Participants answered items about their feelings specific to each individual player/pipe (to what extent each player/pipe ignored, included, and liked them and how much they liked each other player/pipe). The exact same questions were used for each version of the task to allow direct comparisons between the different versions. Although it may seem odd to require participants to make social-emotional judgements about inanimate objects, such as pipes, a similar approach was used after Zadro et al.'s (2004) Cyberball task to assess participants' feelings of being rejected by what they knew was a computer. Evidence, such as that by Milán et al. (2013), showing strong consistency in participants' different social-emotional assessments (e.g., foolish, clever, nice, unpleasant, nervous) of nonsocial and otherwise meaningless stimuli (e.g., abstract shapes with sharp angles vs. rounded curves) also supports the feasibility of assessing participants' social-emotional evaluations of items as distinctly nonsocial as a couple of pipes. Although the wording of these questions can imply that players/pipes had social agency, any attributions of this nature prompted by the questions regarding the pipes could have only occurred after the game was finished and thus not have affected the behavioral measure.

Results

Behavior

To establish the extent to which the experience of social pain would lead to avoidance of socially painful stimuli over time, a 2 × 2 mixed ANOVA compared how the between-subjects factor version of Cyberball (social vs. nonsocial) and the within-subjects factor of time (first 10 throws vs. last 10 throws) influenced the proportion of throws the participant made to the rejecting player over the course of the game (see Fig. 2).

The interaction between the version of Cyberball (social vs. nonsocial) and time was significant, $F(1, 159) = 8.37$, $p < .01$, $\eta^2 = .05$. In the social version, participants passed the ball to the rejecting player significantly less often during the last 10 throws than during the first 10, $t(80) = 3.05$, $p < .01$, whereas in the nonsocial version, there was no difference in throwing behavior, $t(79) = -1.10$, *ns*. The overall main effects of version



Note. Potential range for y-axis: 0-100 %.

Fig. 2 Mean percentage of throws to rejecting stimuli in social and nonsocial versions of Cyberball

of Cyberball (social vs. nonsocial) and time were both nonsignificant, $F(1, 159) = 2.09$, *ns*, and $F(1, 159) = 1.67$, *ns*, respectively.

Subjective feelings specific to individual stimuli

To examine the specificity of rejection-related negative affect, participants' self-reported subjective feelings about individual players (rejecting vs. fair playing) were compared as a function of whether they experienced social or nonsocial rejection. The four measures (feeling included, excluded, liked, and liking the other players/pipes) were combined to create composite scores (Cronbach's alpha = .88) to reflect how participants felt about the rejecting player/pipe, as well as the fair-playing player/pipe (see Table 1). Using a 2 × 2 mixed ANOVA, we compared how the version of Cyberball (social vs. nonsocial) and the player type (rejecting player/pipe vs. fair-playing player/pipe) influenced subjective feelings. There was a significant interaction, $F(1, 159) = 6.65$, $p = .01$, $\eta^2 = .04$; in the nonsocial version, participants indicated feeling more negatively toward the rejecting pipe than toward the fair-playing pipe. This pattern was also seen in the social version—participants indicated feeling more negatively toward the rejecting player than toward the fair-playing player; however, the difference in ratings was significantly greater in the social than in the nonsocial version. Participants felt more positive toward the fair-playing player than the fair-playing pipe, and more negative toward the rejecting player than the rejecting pipe. The main effect of the specific player was significant, $F(1, 159) = 174.35$, $p < .001$, $\eta^2 = .52$, but the main effect of version of the game (social vs. nonsocial) was not, $F(1, 159) = .72$, *ns*.

Impact of social pain on behavior

We tested whether specific subjective feelings of rejection mediated the effect of version of Cyberball (social vs. nonsocial) on behavior change using the macro MEDIATE, by Hayes and Preacher (2014). Table 2 presents zero-order correlations between variables. MEDIATE provides tests for direct and indirect effects when the predictor variable is categorical. Indirect effects were based on percentile bootstrap confidence intervals. An indirect effect is interpreted as significant if zero is outside of the confidence interval. The confidence intervals were set at 95 % and 5,000 bootstrapping samples were used with replacement. Results are presented in Table 3.

The direct effect of version of Cyberball (social vs. nonsocial) on behavior change was significant ($p = .01$), as were the paths from version of Cyberball to specific subjective feelings and from specific subjective feelings to behavior change ($p < .05$

Table 1 Means and Standard Errors for Ratings of Specific Subjective Feelings in Social and Nonsocial Versions of Cyberball

	Version of Game	
	Social ($N = 81$)	Nonsocial ($N = 80$)
Rating of Feeling	*M* (*SE*)	*M* (*SE*)
Included by fair player	6.16 (.20)	5.73 (.20)
Included by rejecting player	2.99 (.22)	3.66 (.24)
Ignored by fair player*	6.06 (.24)	5.93 (.24)
Ignored by rejecting player*	2.78 (.25)	4.15 (.30)
Liked fair player	6.26 (17)	5.78 (.21)
Liked rejecting player	3.80 (.20)	3.80 (.23)
Liked by fair player	5.85 (.15)	5.63 (.21)
Liked by rejecting player	3.12 (.20)	3.61 (.23)
Composite for fair player	**24.33 (.65)**	**23.06 (.71)**
Composite for rejecting player	**12.69 (.73)**	**15.22 (.86)**
Difference (fair-rejecting) **	***11.64 (1.02)***	***7.84 (1.07)***

Note. *This rating has been reverse scored. For all ratings, lower scores mean more negative feelings. Each scale ranged from 1 to 9 with the exception of the composite score, which ranged from 4 to 36

**Shows the significant interaction reported with participants showing a greater difference in affective ratings in the social than in the nonsocial condition

Table 2 Descriptive Statistics and Correlations Among Study Variables

	M	*SD*	1	2
1. Version of game	.50	.50		
2. Change in behavior	1.99	20.27	.22**	
3. Difference in subjective feelings	9.75	9.52	.20*	.21**

Note. Correlations are Pearson product or biserial depending on the involvement of version of game (social vs. nonsocial) as a dichotomous variable

*Correlation is significant at the .5 level (two-tailed)

**Correlation is significant at the .01 level (two-tailed)

Table 3 Direct and Indirect Effects of Version of Cyberball (Social vs. Nonsocial) on Behavior Change Through Subjective Feelings

Path	*B* (*SE*)	*t*	Boot-strapping (*SE*)	Bias-corrected and accelerated CIs	Overall Model R^2	*F*(*df*)
V-BC	3.15	2.39*				
V-SSF	1.48	2.58*				
SF-BC	.17	2.18*				
V-SF-BC			.95	.10, 4.10	.08	6.55(2,158)**

Note. V is version of Cyberball (social vs. nonsocial); BC is behavior change; SSF is specific subjective feelings

*Significance at the .05 level

**Significance at the .01 level

for both). Together, specific subjective feelings and version of Cyberball account for a significant portion of variance in behavior change, $R^2 = .08$, $F(3, 157) = 4.58$, $p < .01$, Cohen's $f^2 = .09$. The indirect effect of version of Cyberball on behavior change through specific subjective feelings was also significant, lower level of confidence interval [LLCI] = .09, upper level of confidence interval [ULCI] = 3.87, indicating that the effect of version of Cyberball is at least partially mediated by subjective feelings and that social context influences behavior due in part to the effect of negative feelings generated by social rejection.

Discussion

This study investigated the impact of social pain on behavior during social interactions. It was hypothesized that individuals would respond to social pain, caused from social rejection during a game of Cyberball, by adapting their behavior to avoid the source of that pain and thereby favor more productive social interactions. We found that when participants believed they were interacting with other participants in the social version of Cyberball, they learned to avoid the rejecting individuals by throwing to them less over the course of the game. This same effect was not observed when participants believed that they were playing with a network of pipes in the nonsocial version of Cyberball. Because the sole difference between the two versions of Cyberball was social context, this finding shows that some factor intrinsic to the social context caused participants to change their behavior. Composite scores assessing the overall difference in subjective feelings toward the rejecting and fair-playing stimuli were most negative toward the rejecting player and most positive toward the fair-playing player in the social version. Therefore, although participants are sensitive to exclusion and report feelings of negative affect toward the pipe in the nonsocial version, they report significantly greater sensitivity to exclusion by the player in the social version, which results in changes in their behavior.

Similarly, a study by Zadro and colleagues (2004) found that participants expressed feelings of pain after they were excluded by computers. Zadro et al. compared subjective feelings after exclusion versus inclusion during Cyberball and found no impact of the source of the inclusion or exclusion (computer vs. human). Our findings of significantly greater negative affect toward the rejecting stimulus in the social version therefore seems to contradict these previous findings. However, although Zadro et al. told participants that they were playing with either computers or humans, the on-screen images were always three human avatars playing the game together. Thus, the discrepancy between their findings and ours could be because of the presence of social cues in their study and the complete lack of social cues within our nonsocial condition.

The negative feelings caused by the social version of Cyberball were expected to account for changes in behavior seen over the course of the game. If subjective feelings of social pain cause a decrease in throws to the rejecting individual, they should be able to predict changes in observed behavior. This is, in fact, what we found; differences in subjective feelings were a significant predictor of behavior change over the course of the game and mediated the effect of version of Cyberball (social vs. nonsocial) on behavior change. However, even when these changes in subjective feelings were accounted for, there was still a direct effect of version of Cyberball on changes in behavior. This suggests that other factors related to the social context were influencing changes in behavior, or that the way in which subjective feelings were measured did not fully capture the emotional experience of the participants.

One possibility in this regard is that implicit factors—in addition to the effects of explicit feelings—may have contributed to the changes in behavior we observed. During the social version, for example, participants may have implicitly learned to avoid the rejecting player because of unconscious feelings of negative affect (Winkielman & Berridge, 2004). These feelings, not accessible through introspection, may have been elicited by the rejecting player acting in a way that violated the participants' expectations of how a social interaction should take place (Spicer et al., 2007). These same expectations would not be present in a nonsocial interaction and could represent a factor intrinsic to the social context that impacted

participants' behavior. Use of other measures, such as galvanic skin response or pupillary dilation, may be a better way to understand the role of these implicit factors in prioritization of social interactions above and beyond explicit self-reporting of social pain.

Although the procedures and measures used in our study were clearly sufficient to detect changes in throwing behavior resulting from social exclusion on in the Cyberball task, it is nevertheless useful to consider how the sensitivity of such an approach could be enhanced in future studies. Thus, another possibility is that explicit self-report measures obtained well after exclusion has taken place may not be sensitive to all aspects of experienced social pain. That is, requiring that participants reflect back on their experience of pain during the episode of exclusion may not be as accurate as measurements obtained at the time when the pain was experienced. Other studies have shown that rejection can rapidly affect physiological measures of distress, such as skin conductance and heart rate, in line with explicit posttask measures, such as self-report questionnaires (Iffland, Sansen, Catani, & Neuner, 2014; Kelly, McDonald, & Rushby, 2012). Although this supports the validity of the paradigm for eliciting feelings of social rejection, studies that only use explicit, self-report measures after the task may not solely reflect the experience of social pain in its entirety. Future research should continue to aim to combine both indirect measures and explicit reports of social pain obtained during and after the Cyberball task to better assess the extent of their combined influence on behavior during social interactions.

Our hypothesis that participants would respond to social pain, caused from social rejection during a game of Cyberball, by adapting their behavior to avoid the source of that pain was based on what is known about the function of physical and social pain and on previous work with the Cyberball paradigm (e.g., Eisenberger et al., 2003; MacDonald & Leary, 2005). And our results are indeed consistent with this hypothesis, with negative affect directed toward the rejecting player/pipe mediating the change in behavior away from source of rejection. However, it is important to note that the specific design of our study meant that any decrease in number of throws to a rejecting player or pipe also meant a corresponding increase in number of throws to the fair-playing player or pipe. Put another way, any *increase* in number of throws to the fair-playing player or pipe meant a corresponding decrease in number of throws to a rejecting player or pipe. Thus, in addition to the significant effects of rejection and negative affect on throwing behavior reported here, it is possible that participants were also attracted to and increased throws to the fair player/pipe to maximize the rewards of such productive interactions. The impact of an attraction to the fair-playing individual in our study presumably would have been greater had the fair player/pipe actively favored participants over the rejecting player/pipe, rather than throwing equally often to the rejecting player/pipe and each of our participants. Thus, whereas the inclusion signal from the fair player/pipe to participants was rather equivocal in our Cyberball task, the rejection signal from the unfair player/pipe was unequivocal. A direct manipulation of the relative salience of such inclusion and exclusion signals could therefore be useful to differentiate the now-established effects of the pain of exclusion on subsequent social interactions from the potential effects of inclusion-related reward. This could be achieved in future research by, for example, employing a third player in a Cyberball task to allow an assessment of the separate affective and behavioral reactions to a clearly rejecting player, a clearly inclusive player, and an objectively neutral player.

In addition to the potential reward of throwing to the fair playing player, individuals often show a bias to maintain their current or previous decision (e.g., the default bias; Samuelson & Zeckhauser, 1988). Thus, if participants began by throwing the ball to the fair-playing player, they may be more likely to continue throwing the ball to the fair-playing player. Our results suggest that the impact of social rejection is sufficient to overcome this bias. Whereas there was an initial tendency for participants to favor the rejecting player/pipe, this bias did not continue throughout the course of the game for participants in the social version of the game because of the impact of rejection. In contrast, mechanisms that act to increase the efficiency (or reduce the uncertainty) of our response choices, such as continuing to make the same decision, may work together with mechanisms underlying the behavioral impact of social rejection to maintain their behavioral influence.

The main focus of our analyses of throwing behavior was the extent to which the number of throws to a rejecting player/pipe would decrease from the beginning of the ball-tossing game to the end of the game, and the extent to which such a decrease would be more pronounced in the social condition in which participants thought they were playing the game with other participants. And while it was assumed that participants would begin the game by throwing equally often to each player/pipe, inspection of Fig. 2 shows that participants across both groups initially showed a slight yet significant bias favoring the unfair player/pipe, with an average of 53.8 % tosses to the unfair player/pipe and 46.2 % to the fair player/pipe. A one-sample t test revealed that this percentage of tosses to the unfair player/pipe was significantly greater than the expected 50 %, $t(160) = 3.25$, $p = .001$. Although its exact basis remains unclear, informal discussions with participants during postexperimental debriefing do yield some clues about this initial bias toward the unfair player/pipe. Comments from a small number of participants, for example, indicate that they had specifically thrown to the unfair player/pipe because they "didn't think it was working," to "make sure it wasn't because I was not throwing enough to them," to "see if there would be a change," or because they "wanted to create a throwing

pattern." We take such comments to suggest that some participants in both groups may have been aware of the discrepancy in the number of ball tosses they were receiving from each of the different players/pipes and therefore may have initially strategically altered their throwing behavior as a means of exploring or "fixing" this discrepancy. Future research might include more detailed questions about the rationale for participants' in-task choices in addition to their self-reported affective experience.

It is important to emphasize that, despite this initial bias toward the unfair player/pipe, the throwing behavior in the social condition changed over time to ultimately avoid the unfair player, whereas no such change occurred in the nonsocial condition. We take this as clear evidence that rejection that is social in nature leads to changes in behavior. Moreover, participants reported more negative feelings toward the rejecting stimulus in the social than the nonsocial version. These subjective feelings of social pain mediated the effect of version of the game on changes in behavior, indicating that social pain from social rejection causes changes in behavior.

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