

Facing social exclusion: a facial EMG examination of the reaffiliative function of smiling

Joseph C. Brandenburg, Daniel N. Albohn, Michael J. Bernstein, Jose A. Soto, Ursula Hess & Reginald B. Adams

To cite this article: Joseph C. Brandenburg, Daniel N. Albohn, Michael J. Bernstein, Jose A. Soto, Ursula Hess & Reginald B. Adams (2022) Facing social exclusion: a facial EMG examination of the reaffiliative function of smiling, *Cognition and Emotion*, 36:4, 741-749, DOI: [10.1080/02699931.2022.2041404](https://doi.org/10.1080/02699931.2022.2041404)

To link to this article: <https://doi.org/10.1080/02699931.2022.2041404>

 [View supplementary material](#) 

 Published online: 17 Feb 2022.

 [Submit your article to this journal](#) 

 Article views: 172

 [View related articles](#) 

 [View Crossmark data](#) 

BRIEF ARTICLE



Facing social exclusion: a facial EMG examination of the reaffiliative function of smiling

Joseph C. Brandenburg^a, Daniel N. Albohn^b, Michael J. Bernstein^c, Jose A. Soto^a, Ursula Hess^d and Reginald B. Adams^a

^aDepartment of Psychology, The Pennsylvania State University, University Park, PA, USA; ^bBooth School of Business, The University of Chicago, Chicago, IL, USA; ^cDepartment of Psychology, The Pennsylvania State University, Abington, PA, USA; ^dDepartment of Psychology, The Humboldt University of Berlin, Berlin, Germany

ABSTRACT

Social exclusion influences how expressions are perceived and the tendency of the perceiver to mimic them. However, less is known about social exclusion's effect on one's own facial expressions. The aim of the present study was to identify the effects of social exclusion on Duchenne smiling behaviour, defined as activity of both *zygomaticus major* and the *orbicularis oculi* muscles. Utilising a within-subject's design, participants took part in the Cyberball Task in which they were both included and excluded while facial electromyography was measured. We found that during the active experience of social exclusion, participants showed greater *orbicularis oculi* activation when compared to the social inclusion condition. Further, we found that across both conditions, participants showed greater *zygomaticus major* muscle activation the longer they engaged in the Cyberball Task. Order of condition also mattered, with those who experienced social exclusion before social inclusion showing the greatest overall muscle activation. These results are consistent with an affiliative function of smiling, particularly as social exclusion engaged activation of muscles associated with a Duchenne smile.

ARTICLE HISTORY

Received 1 October 2021
Revised 7 February 2022
Accepted 8 February 2022

KEYWORDS

Smiles; social exclusion;
facial EMG; reaffiliation

Over the past two decades, research related to the impact of social exclusion on health (Williamson et al., 2018), personal well-being (DeWall & Baumeister, 2006), relationships (Bernstein et al., 2010), cognition (Baumeister et al., 2002), and self-regulation (Baumeister et al., 2005) has garnered much attention (Hartgerink et al., 2015). Despite the negative side effects, individuals tend to engage in more prosocial behaviours following social exclusion (Bernstein et al., 2008, 2010; Gardner et al., 2000). Although at first surprising, research suggests this effect is due to a need to reaffiliate with others (Gardner et al., 2000; Leary, 2005; Maner et al., 2007; Spoor & Williams, 2007; Williams & Sommer, 1997). One notion that has received increased attention is that social exclusion seems to heighten attention toward potentially

reaffiliative facial cues (Bernstein et al., 2008, 2010; Gardner et al., 2000). In the present work, we examined whether social exclusion also influences reaffiliative expressivity.

Social exclusion shapes our preferences for certain expressions (Bernstein et al., 2008, 2010; DeWall et al., 2009) and how we mimic other individuals' expressions (Kawamoto et al., 2014; Philipp et al., 2021). Yet, to date, the focus has been on perception of faces and behaviour after the experience of rejection. By contrast, less is known about what happens during the active experience of social exclusion. No study, to our knowledge, has employed facial electromyography (EMG) to quantify the direct experience at the muscular level during the experience of social exclusion. The purpose of our research was to

examine which facial muscles become activated during the experience of social exclusion. We tested whether individuals showed signs of reaffiliation through facial muscle activation during social exclusion by measuring two major facial muscles used in the most common reaffiliative expression, smiling.

Social exclusion can lead to both maladaptive and prosocial behaviours (Baumeister et al., 2002; Baumeister et al., 2005; Bernstein et al., 2008, 2010; see Bernstein, 2016 for review; Leary et al., 2006). Maladaptive responses to social exclusion include increased aggression, impaired self-regulation, and reduced cognitive performance (e.g. lower IQ scores and graduate record examination test performance; Baumeister et al., 2002; Baumeister et al., 2005; Bernstein et al., 2010; Leary et al., 2006). To explain some of these negative consequences of social exclusion, Williams (1997) proposed *The Needs Threat Model of Ostracism* which posits that social exclusion deprives people of four basic needs of human existence: belongingness, self-esteem, control, and meaningfulness (Williams, 1997). The model assumes that depending on which of the four needs is threatened, an individual engages in behaviours to regain that lost need. For example, if the need for belongingness was threatened, reaffiliative behaviour would be shown in an attempt to have that need met and satisfied again. More specifically, once these needs are threatened, individuals seek to regain acceptance from the social group or avoid more negative feelings from further rejection (Kawamoto et al., 2014). Thus, social exclusion can lead to maladaptive and/or reaffiliative behaviours, depending on which underlying needs are threatened. Similar theories have been proposed by Maner and colleagues (2007), Spoor and Williams (2007), and Leary (2005), who all postulate that social exclusion leads to behaviours to re-engage social connections.

Social exclusion also has effects on cognitive processes that can further strengthen reaffiliative behaviour. Saito et al. (2020) demonstrated that individuals who felt lonelier were more likely to have their attention drawn to reaffiliative cues in their environment. Similarly, social exclusion leads to increased sensitivity to social cues that can establish reconnection with others. This includes specific types of social facial cues, such as smiling (Bernstein et al., 2008, 2010; DeWall et al., 2009). Such sensitivity to the face is likely due to the information about one's social standing with others that is conveyed by nonverbal behaviour, in particular facial expressions. For example, it is

likely that social exclusion increases sensitivity to pro-social facial cues in an effort to determine whether affiliative actions will be reciprocated and to assess whether belongingness needs will be satisfied (Bernstein et al., 2010). Considered together, these findings converge on the conclusion that being socially excluded heightens one's sensitivity to reaffiliative information and gives rise to greater reaffiliative behaviour.

Social exclusion not only affects behaviour following the exclusion event but also during the event. Paolini et al. (2016) asked participants to complete the Cyberball Task (a task commonly used to manipulate both social exclusion and inclusion) in a within-subjects design while measuring participants' face temperatures. They found significant changes in temperature around the nose, perioral, and eye regions when they compared the baseline condition to inclusion and exclusion conditions. From these results, we would suspect that social exclusion has implications for psychophysiological mechanisms that underlie the experience of exclusion (Paolini et al., 2016).

More relevant in the present context, Williams and Sommer (1997) coded individuals' nonverbal behaviour during the Cyberball Task conditions of social exclusion and social inclusion. Two general categories were created to encompass participants' behaviour: engagement (forward lean, talking, and eye contact) and ambiguous behaviour (smiling, object manipulation, and laughing). Participants in the social inclusion condition displayed more engagement behaviours. Further, in the inclusion condition individuals displayed more smiling and laughing behaviour than during exclusion, with the most pronounced effects within female participants (Williams & Sommer, 1997). However, the authors stated that smiling behaviour was also noted within the social exclusion group, and they did not specifically examine indicators of smiling around the eyes (i.e. the *orbicularis oculi*; the Duchenne Marker, Duchenne, 1862/1990). This study provides initial confirmatory evidence for smiling during both social inclusion and social exclusion.

Smiling is a ubiquitous behaviour, which can have different meanings (Niedenthal et al., 2010). Smiling can be used in many contexts, but one important function of smiling is to signal affiliation (Knutson, 1996). Smiles, and in particular so-called Duchenne smiles which combine the lifting of the corners of the mouth with wrinkles around the eyes, are

considered markers of affiliation (Hess et al., 2000). These smiles are also considered more authentic, at least in Western cultures (Thibault et al., 2012). As such, the use of smiles, especially of Duchenne-smiles, as affiliative signals can be expected when people want to reaffiliate with their social environment.

Current study

The purpose of this study was to examine individuals' facial muscle activation during social exclusion. The current work examined reaffiliative facial expressions (smiling) during the experience of social exclusion. In a within-subjects design, participants were socially excluded and socially included via the Cyberball Task while outfitted with EMG sensors on their *orbicularis oculi* and *zygomaticus major* muscles. We predicted increased *zygomaticus major* as well as *orbicularis oculi* muscle activation in the social exclusion condition compared to the social inclusion condition. If both muscles show heightened activation independently of each other, then we could surmise that the combination would be indicative of more reaffiliative behaviour during social exclusion compared to social inclusion. We also anticipated possible interactions involving order of condition given the current within-participant study design. Specifically, it is possible that being included before being excluded would result in a "social buffer" protecting participants from the negative effects typically observed in social exclusion. It is also plausible that individuals might seek out affiliation more if they are initially included then excluded. Additionally, it is also possible that being excluded first followed by being included would result in carry over effects, whereby the negative effects of social exclusion continue through the experience of being socially included. Given that no work, to our knowledge, has examined this before, we made no predictions as to which (if any) of these effects would occur and include them as exploratory, preliminary analyses.

Method

Participants

Our sample consisted of 57 undergraduate students (29 women, $M = 19.45$, $SD = 1.66$) who completed the study for partial course credit. We conducted a sensitivity analysis which confirmed that the design is suitable to detect an effect of $f = .22$. (Supplemental Materials 1).

Data from our laboratory show that mimicry effects tend to range from $\eta_p^2 = .15$ to $\eta_p^2 = .30$.

Design and procedure

Participants were outfitted the EMG sensors. EMG activity was measured by a pair of two 4 mm Ag/AgCl electrodes (BIOPAC Systems Inc., Santa Barbara, CA). Bipolar EMG signal was recorded under each participant's right eye and on the cheek, directly on their *orbicularis oculi* and *zygomaticus major* muscle (Van Boxtel, 2010). Skin was prepared with abrasive gel and alcohol before electrode placement to ensure that the impedance was under 30 kilohms (Hess, 2009). EMG was grounded via the electrodes that also measured skin conductance placed on their non-dominant hand middle and pointer fingers. A Biopac MP-150 (BIOPAC Systems Inc., Santa Barbara, CA) collected the data at 1000 Hz. Participants were randomly assigned in a within-subjects design to the social exclusion or social inclusion condition first and then completed the opposite condition. The current Cyberball task had a total of 3 players (2 computer generated players and the participant). Two sets of two images each (four images total) of smiling undergraduate students (taken from an internal database) were shown with the standard Cyberball computer avatars. These images were used to increase the likelihood that participants would believe that they were playing with other undergraduates from other universities. One set of images was randomly selected to be displayed with the inclusion condition, while the other was presented during the exclusion condition. Thus, all participants saw all images, reducing any systematic bias that the images may have had on study outcomes. After completion of each Cyberball condition, participants completed the Basic Needs Questionnaire (see Supplemental Materials 1 for materials description) to measure feelings of rejection (Williams et al., 2000).

The Cyberball task has been utilised in over 120 studies to manipulate social exclusion (for review see Hartgerink et al., 2015). The Cyberball task was designed as an experience of ostracism where participants play a ball tossing game with what they believe are other participants. However, in reality the other players are preprogrammed by the researchers. Participants are instructed to mentally visualise themselves as playing a ball tossing game in real life. During the game they are either thrown the ball by the other two players (social inclusion) for the

duration of the task or they are thrown the ball once by each of the other players at the start of the game and then not thrown the ball for the remainder of the task (social exclusion). The task lasts for approximately three minutes (i.e. for a total of 50 throws; Kawamoto et al., 2014).

Participants completed a 15-minute survey between each Cyberball Task. The 15-minute survey consisted of categorizing different types of smiles and was unrelated to the current research question (s), and thus acted as a filler for the current work.

After completing both blocks, each participant completed the Berkeley Emotional Expressivity Scale (Gross & Oliver, 1997), the Questionnaire Measure of Emotional Empathy (QMEE; Mehrabian & Epstein, 1972), and demographic questionnaires. Participants were then verbally debriefed by research assistants and were asked if they believed they were playing the Cyberball task with other undergraduate students. Each condition was counterbalanced across participants to account for potential order effects.

Results

Basic needs questionnaire

Following the analyses in Bernstein et al. (2010), we first calculated the scores of each of the basic needs subscales (meaningfulness, self-esteem, belongingness, and control). Next, we formed a composite basic needs score by adding participants scores on each subscale together. Higher scores on the composite were indicative of higher feelings of meaningfulness, self-esteem, belongingness, and control. We then used a linear mixed effects regression to compare the social exclusion condition to the social inclusion condition with fixed effects for social exclusion condition and random intercepts for each participant. We found significant differences $F(1, 55) = 158.56, p < .001$, whereby socially included individuals ($M = 74.6, SD = 12.34$) had higher composite scores compared to the socially excluded individuals ($M = 46.5, SD = 11.36$). These results suggest that participants when socially excluded had significantly less fulfilled basic needs or felt more socially excluded compared to when they were socially included.

Orbicularis oculi activation

The magnitude of the EMG signal was baseline corrected by dividing the data during each condition

by the 5000 ms baseline period that was recorded while participants were given instructions (for extended data reduction procedures see Supplemental materials 1).

A linear mixed-effects regression with fixed effects for the social exclusion condition and time epoch and a random effect for participant on *orbicularis oculi* muscle activation in the social exclusion condition yielded a main effect of condition $F(1, 4827) = 9.28, p = .002$ (see Figure 1). Participants in the social exclusion group ($M = 1.52, SD = 1.37$) had higher *orbicularis oculi* activation compared to the social inclusion group ($M = 1.25, SD = .95$). We also found a main effect of time $F(1, 4824) = 10.15, p = .001$, suggesting that as time elapsed participants exhibited greater *orbicularis oculi* activation in both conditions. We further found a marginally significant Condition \times Time interaction, $F(1, 4824) = 3.78, p = .052$, suggesting that those who were socially excluded showed more *orbicularis oculi* activation as the task elapsed (epoch) compared to those who were in the social inclusion condition. However, since this interaction was only marginally significant, we interpret this effect with caution.

Zygomaticus major activation

The linear mixed model on individuals' *zygomaticus major* muscle by social exclusion condition yielded a significant effect of Time $F(1, 4824) = 4.59, p = .032$. Over time, regardless of condition, *zygomaticus major* muscle activation increased ($b = .003$) as participants played the Cyberball task. There were no significant interactions.

Interactions involving order of condition for orbicularis oculi

Given that social exclusion and social inclusion are rarely examined in a within-subjects design, we tested to see if any interactions involving order of condition existed. For *orbicularis oculi* activation, we assessed a linear mixed model with condition order as a fixed effect. *Orbicularis oculi* activation showed a main effect of Time, $F(1, 4625) = 5.09, p = .02$ (see Figure 2). As time elapsed, there was greater *orbicularis oculi* muscle activation across conditions and order ($b = .003$). We also found an interaction between Order and Condition, $F(1, 4628) = 33.55, p < .001$. Specifically, when participants were first socially excluded ($M = 1.82, SD = 1.53$) and then

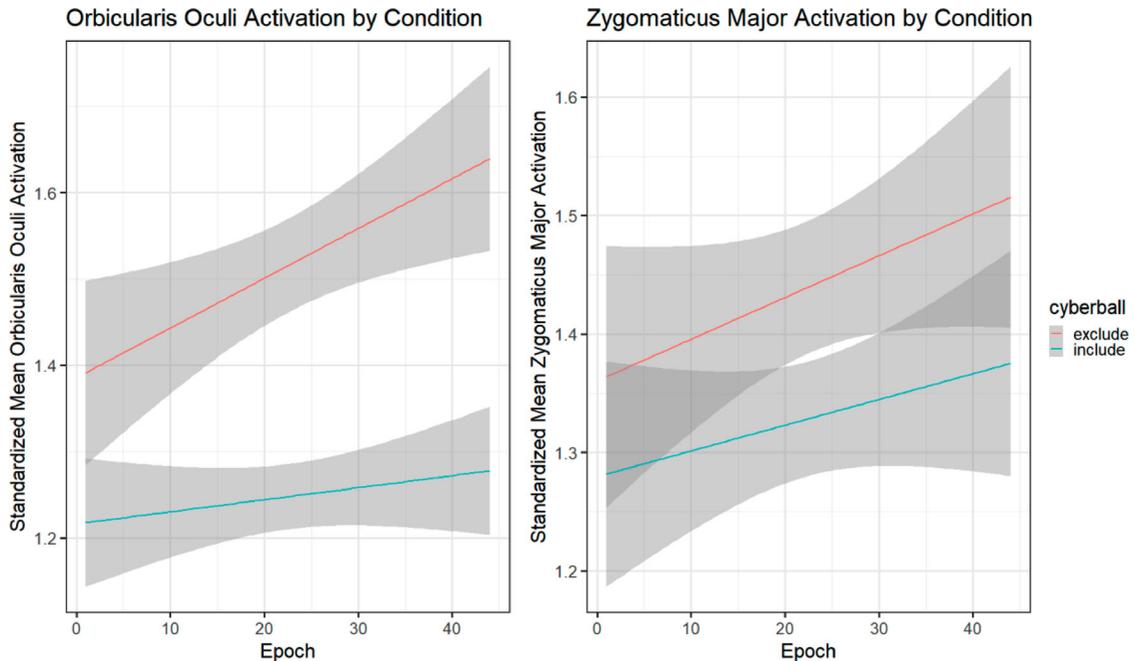


Figure 1. Graphs depicting the *orbicularis oculi* and *zygomaticus major* muscle activation by condition of social exclusion and social inclusion.

socially included ($M = 1.14$, $SD = 1.18$) there were significant differences in levels of *orbicularis oculi* muscle activation. However, when participants were first socially included ($M = 1.24$, $SD = .97$) and then excluded ($M = 1.31$, $SD = .95$) there were no significant differences detected.¹

Interactions involving order of condition for zygomaticus major

For *zygomaticus major* muscle activation the linear mixed model yielded an interaction between Order and Condition $F(1, 4629.5) = 5.11$, $p = .024$ (see Figure 2). Specifically, when participants were first socially excluded ($M = 1.66$, $SD = 1.37$) and then included ($M = 1.32$, $SD = 1.28$) there were significant differences in levels of *zygomaticus major* muscle activation demonstrated in Figure 2. However, when participants were first socially included ($M = 1.33$, $SD = 1.16$) and then excluded ($M = 1.22$, $SD = 1.47$) there were no significant differences.

We also found an interaction between Time \times Order $F(1, 4624.9) = 10.11$, $p = .001$. Specifically, participants who were first socially excluded had a significantly different slope compared to the participants in

the socially included then socially excluded group ($b = .009$, $SE = .003$, $p = .002$) (Table 1).²

Discussion

Our findings are in line with a growing body of research suggesting that social exclusion leads to reaffiliative responses at the physiological level (Kawamoto et al., 2014; Lakin & Chartrand, 2005; Paolini et al., 2016; Philipp et al., 2021).

Contrary to our hypothesis, we did not find any significant differences for the *zygomaticus major* muscle when comparing conditions. However, we did find a main effect of time which suggests that, regardless of condition, participants were engaging in more smiling behaviour as the Cyberball task continued. That is, participants smiled in both conditions.

Importantly however, during social exclusion, participants showed heightened activation of the *orbicularis oculi* muscle in line with our hypothesis. We also found that the longer someone was socially excluded the more *orbicularis oculi* activation they demonstrated. The addition of *orbicularis oculi* to *zygomaticus major* activation (Duchenne smiles) signals cooperative intentions and reaffiliation (Sheldon

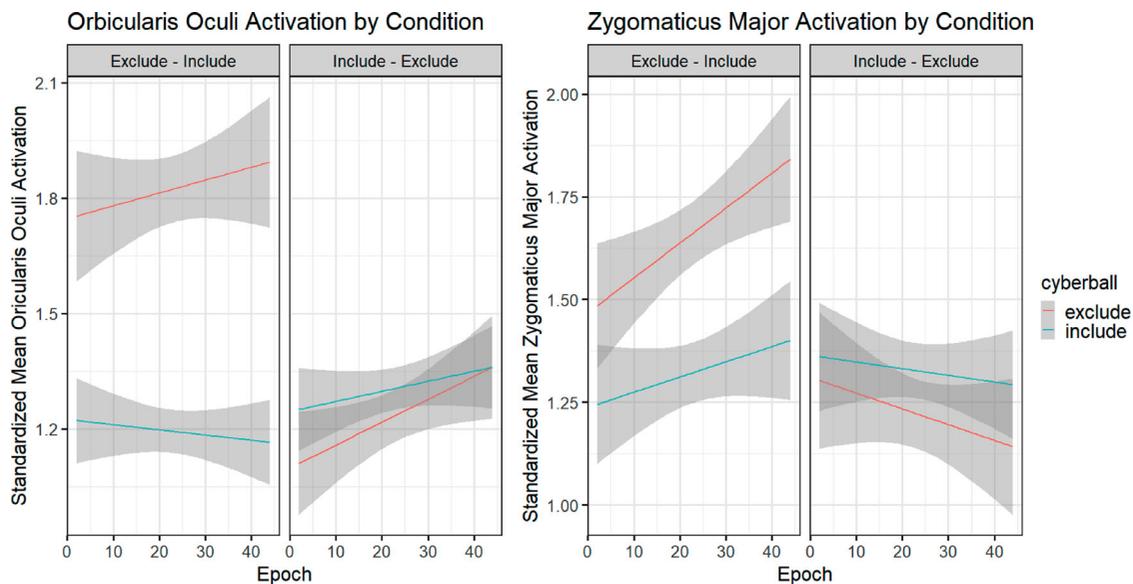


Figure 2. Graphs depicting the *orbicularis oculi* and *zygomaticus major* muscle activation by condition order and condition (social exclusion and social inclusion).

et al., 2021). Lastly, when we accounted for condition order, we found that individuals in the social exclusion followed by social inclusion condition were driving the main effects when results were collapsed across groups. When social exclusion was followed by social inclusion, individuals showed heightened *orbicularis oculi* and *zygomaticus major* muscle activation. However, when the order was reversed, no significant differences between the conditions emerged for both *orbicularis oculi* and *zygomaticus major* muscles. These results suggest that our hypothesis was partially

correct as we found heightened *zygomaticus major* muscle activity in the social exclusion condition, but only when social exclusion followed social inclusion. In line with our exploratory hypothesis, these results suggest that being socially included directly prior to being socially excluded had a buffering effect against the negative aspects of social rejection. However, we did not find the inverse effect where social exclusion did not carry over to the social inclusion condition. This latter observation is an interesting point to consider for future research as, to our knowledge, no work has examined such effects in a within-person design.

Taken together, these results suggest that during social exclusion individuals demonstrate muscle activity congruent with affiliative behaviour. More specifically, those who were socially excluded showed heightened activation of both the *orbicularis oculi* and *zygomaticus major*, the two muscles primarily involved in Duchenne smiles. In other words, the activation of both *zygomaticus major* and *orbicularis oculi* occurred in the absence of positive affect, suggesting that the primary utility of this pattern of muscle activation was to engage in affiliative behaviours. This is the first work, to our knowledge, that examined effects of social exclusion “in the moment” on facial muscle responses utilising EMG. Further, we employed a within-subject’s design to examine social exclusion/inclusion effects on direct

Table 1. ANOVA summary table for *zygomaticus major* and *orbicularis oculi* activation.

Effect	df	F	p
Zygomaticus major activation			
Cyberball (Include/Exclude)	4629.5	2.33	.127
Condition Order	70.4	0.01	.937
Epoch (Time)	4624.9	1.48	.225
Cyberball × Condition	4624.9	5.11	.024
Cyberball × Epoch	4624.9	0.22	.642
Condition × Epoch	4624.9	10.11	.002
Cyberball × Condition × Epoch	4624.9	1.60	.207
Orbicularis oculi activation			
Cyberball (Include/Exclude)	4628	11.57	<.001
Condition Order	64.2	2.33	.131
Epoch (Time)	4625	5.09	.024
Cyberball × Condition	4628	33.55	<.001
Cyberball × Epoch	4625	2.93	.087
Condition × Epoch	4625	1.97	.161
Cyberball × Condition × Epoch	4625	0.08	.773

facial muscle activation. This work lends further support to the notion that social exclusion leads individuals to engage in reaffiliative action.

The effects of social exclusion were qualified by the order in which participants experienced social inclusion and exclusion, even with 15 minutes between each Cyberball condition. Thus, we partially supported the hypothesis that *zygomaticus major* muscle activation should be higher in the social exclusion compared with the social inclusion condition. Little is known about whether social inclusion can buffer the effects of social exclusion. Eck et al. (2016) argued that just the companionship of a stranger is an effective buffer against social exclusion. However, in this case the social inclusion event occurred just prior to a social exclusion event and this may be a context where social inclusion by a stranger can act as a buffer. Specifically, social inclusion may satisfy participants' belonging needs so they are less threatened by subsequent social exclusion effects. This is consistent with *The Needs Threat Model of Ostracism* (Williams, 1997). If there is a buffer to a need that one might have threatened, then an individual may not feel compelled to engage in reaffiliative behaviour to have that need remet.

The within subjects-design is both a strength and a limitation of this work. Using a within-subjects design allowed us to maximise power to detect smaller differences in EMG activity created by the Cyberball Task. However, not much is known about the length of time for social exclusion or inclusion effects on facial muscle activation which might have influenced our results. We tried to account for this by having a 15-minute filler task to mitigate the previous conditions' effects. Future work should examine social exclusion effects following the Cyberball Task on EMG activity given that we cannot conclude that social rejection stops once the last round of social rejection is complete. We also had a large enough sample to infer meaningful results for participants in each distinct condition order. Future work should utilise within-subjects designs to examine the effects of social exclusion and social inclusion on one another. Additionally, future studies should seek out to test how fEMG responses differ during the socially excluding event compared to following it. Given the current results, it would also be important to examine whether participants would show more reaffiliative responses in the physical presence of others. It is likely that the most pronounced effects of reaffiliation smiles would occur when individuals are socially

accepted or rejected in real face-to-face interactions with other individuals. Finally, it would be interesting to examine the co-activation between the *zygomaticus major* and *orbicularis oculi* muscle during social exclusion.

Conclusions

Overall, results from the current study suggest that individuals show increased reaffiliative behaviour while being socially excluded as measured by facial muscle activation associated with smiling. More specifically, in the social exclusion condition, participants showed heightened activation of both the *orbicularis oculi* and *zygomaticus major*, the two muscles primarily involved in the expression of a Duchenne smile. We argue that social exclusion compared to social inclusion leads to more reaffiliative cues based on the exclusive activation of the *orbicularis oculi* muscle in the social exclusion group. Not only do individuals show reaffiliative behaviour following socially excluding events, but they also begin to show affiliative cues during the actual socially excluding event itself in order to reaffiliate with others. This work has real world implications for better understanding how individuals signal to others to have their social needs met when they are socially excluded during life events.

Notes

1. The *orbicularis oculi* analyses were rerun utilising only the first condition within each block to further test order effects. We found that even when the number of observations were trimmed to half and the new analysis was now between rather than within, the effects were still significant and in the predicted direction (See Supplemental Materials 2 order effect interactions).
2. The *zygomaticus major* analyses were rerun utilising only the first conditions within each block to further test interactions with order. We found that even when the number of observations were trimmed to half and the new analysis was now between rather than within the effects we found were still significant (See Supplemental Materials 2).

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This project was funded by National Institute of Health R01 MH101194-01A1 to RBA, Jr.

References

- Baumeister, R. F., DeWall, C. N., Ciarocco, N. J., & Twenge, J. M. (2005). Social exclusion impairs self-regulation. *Journal of Personality and Social Psychology*, 88(4), 589–604. <https://doi.org/10.1037/0022-3514.88.4.589>
- Baumeister, R. F., Twenge, J. M., & Nuss, C. K. (2002). Effects of social exclusion on cognitive processes: Anticipated loneliness reduces intelligent thought. *Journal of Personality and Social Psychology*, 83(4), 817–827. <https://doi.org/10.1037/0022-3514.83.4.817>
- Bernstein, M. J. (2016). Research in social psychology: Consequences of short-and long-term social exclusion. In P. Riva & J. Eck (Eds.), *Social exclusion: Psychological approaches to understanding and reducing its impact* (pp. 51–72). Springer International Publishing.
- Bernstein, M. J., Sacco, D. F., Brown, C. M., Young, S. G., & Claypool, H. M. (2010). A preference for genuine smiles following social exclusion. *Journal of Experimental Social Psychology*, 46(1), 196–199. <https://doi.org/10.1016/j.jesp.2009.08.010>
- Bernstein, M. J., Young, S. G., Brown, C. M., Sacco, D. F., & Claypool, H. M. (2008). Adaptive responses to social exclusion: Social rejection improves detection of real and fake smiles. *Psychological Science*, 19(10), 981–983. <https://doi.org/10.1111/j.1467-9280.2008.02187.x>
- DeWall, C. N., & Baumeister, R. F. (2006). Alone but feeling no pain: Effects of social exclusion on physical pain tolerance and pain threshold, affective forecasting, and interpersonal empathy. *Journal of Personality and Social Psychology*, 91(1), 1–15. <https://doi.org/10.1037/0022-3514.91.1.1>
- DeWall, C. N., Maner, J. K., & Rouby, D. A. (2009). Social exclusion and early-stage interpersonal perception: Selective attention to signs of acceptance. *Journal of Personality and Social Psychology*, 96(4), 729–741. <https://doi.org/10.1037/a0014634>
- Duchenne, G. B. (1990). *The mechanism of human facial expression* (R. Andrew Cuthbertson, trans.). Cambridge University Press. (Original work published 1862). <https://doi.org/10.1017/cbo9780511752841.003>
- Eck, J., Schoel, C., & Greifeneder, R. (2016). Coping with or buffering against the negative impact of social exclusion on basic needs: A review of strategies. In P. Riva & J. Eck (Eds.), *Social exclusion: Psychological approaches to understanding and reducing its impact* (pp. 227–249). Springer.
- Gardner, W. L., Pickett, C. L., & Brewer, M. B. (2000). Social exclusion and selective memory: How the need to belong influences memory for social events. *Personality and Social Psychology Bulletin*, 26(4), 486–496. <https://doi.org/10.1177/0146167200266007>
- Gross, J. J., & John, O. P. (1997). Revealing feelings: Facets of emotional expressivity in self-reports, peer ratings, and behavior. *Journal of Personality and Social Psychology*, 72, 435–448.
- Hartgerink, C. H. J., van Beest, I., Wicherts, J. M., & Williams, K. D. (2015). The ordinal effects of ostracism: A meta-analysis of 120 cyberball studies. *PLoS ONE*, 10(5), e0127002. <https://doi.org/10.1371/journal.pone.0127002>
- Hess, U. (2009). Facial EMG. In E. Harmon-Jones & J. S. Beer (Eds.), *Methods in social neuroscience* (pp. 70–91). Guilford Press.
- Hess, U., Blairy, S., & Kleck, R. E. (2000). The influence of expression intensity, gender, and ethnicity on judgments of dominance and affiliation. *Journal of Nonverbal Behavior*, 24(4), 265–283. <http://link.springer.com/article/10.1023/A:1006623213355>, <https://doi.org/10.1023/A:1006623213355>
- Kawamoto, T., Nittono, H., & Ura, M. (2014). Social exclusion induces early-stage perceptual and behavioral changes in response to social cues. *Social Neuroscience*, 9(2), 174–185. <https://doi.org/10.1080/17470919.2014.883325>
- Knutson, B. (1996). Facial expressions of emotion influence interpersonal trait inferences. *Journal of Nonverbal Behavior*, 20(3), 165–182. <https://doi.org/10.1007/BF02281954>
- Lakin, J. L., & Chartrand, T. L. (2005). Exclusion and nonconscious behavioral mimicry. In K. D. Williams, J. P. Forgas, & W. von Hippel (Eds.), *The social outcast: Ostracism, social exclusion, rejection, and bullying* (pp. 279–295). Psychology Press.
- Leary, M. R. (2005). Sociometer theory and the pursuit of relational value: Getting to the root of self-esteem. *European Review of Social Psychology*, 16(1), 75–111. <https://doi.org/10.1080/10463280540000007>
- Leary, M. R., Twenge, J. M., & Quinlivan, E. (2006). Interpersonal rejection as a determinant of anger and aggression. *Personality and Social Psychology Review*, 10(2), 111–132. https://doi.org/10.1207/s15327957pspr1002_2
- Maner, J. K., DeWall, C. N., Baumeister, R. F., & Schaller, M. (2007). Does social exclusion motivate interpersonal reconnection? Resolving the “porcupine problem”. *Journal of Personality and Social Psychology*, 92(1), 42–55. <https://doi.org/10.1037/0022-3514.92.1.42>
- Mehrabian, A., & Epstein, N. (1972). A measure of emotional empathy. *Journal of Personality*, 40(4), 525–543. <https://doi.org/10.1111/j.1467-6494.1972.tb00078.x>
- Niedenthal, P. M., Mermillod, M., Maringer, M., & Hess, U. (2010). The simulation of smiles (SIMS) model: Embodied simulation and the meaning of facial expression. *Behavioral and Brain Sciences*, 33(6), 417–433. <https://doi.org/10.1017/S0140525X10000865>
- Paolini, D., Alparone, F. R., Cardone, D., van Beest, I., & Merla, A. (2016). “The face of ostracism”: The impact of the social categorization on the thermal facial responses of the target and the observer. *Acta Psychologica*, 163, 65–73. <https://doi.org/10.1016/j.actpsy.2015.11.001>
- Philipp, M. C., Bernstein, M., Vanman, E. J., & Johnston, L. (2021). Social exclusion enhances affiliative signaling. *The Journal of Social Psychology*, 161(4), 508–518. <https://doi.org/10.1080/00224545.2020.1854648>
- Saito, T., Motoki, K., Nouchi, R., Kawashima, R., & Sugiura, M. (2020). Loneliness modulates automatic attention to warm and competent faces: Preliminary evidence from an eye-tracking study. *Frontiers in Psychology*, 10(1), 1–10. <https://doi.org/10.3389/fpsyg.2019.02967>
- Sheldon, K. M., Corcoran, M., & Sheldon, M. (2021). Duchenne smiles as honest signals of chronic positive mood. *Perspectives on Psychological Science*, 16(3), 654–666. <https://doi.org/10.1177/1745691620959831>
- Spoor, J. R., & Williams, K. D. (2007). The evolution of an ostracism detection system. In J. P. Forgas, M. G. Haselton, & W. von Hippel (Eds.), *Sydney symposium of social psychology. Evolution and the social mind: Evolutionary psychology and social cognition* (pp. 279–292). Routledge/Taylor & Francis Group.
- Thibault, P., Levesque, M., Gosselin, P., & Hess, U. (2012). The duchenne marker is not a universal signal of smile

- authenticity – But it can be learned!. *Social Psychology*, 43(4), 215–221. <https://doi.org/10.1027/1864-9335/a000122>
- Van Boxtel, A. (2010). Facial EMG as a tool for inferring affective states. In *Proceedings of measuring behavior 7*, 104–108. [http://measuringbehavior.org/files/ProceedingsPDF\(website\)/Boxtel_Symposium6.4.pdf](http://measuringbehavior.org/files/ProceedingsPDF(website)/Boxtel_Symposium6.4.pdf)
- Williams, K. D. (1997). Social ostracism. In R. M. Kowalski (Ed.), *The Plenum series in social/clinical psychology. Aversive interpersonal behaviors* (pp. 133–170). Plenum Press. https://doi.org/10.1007/978-1-4757-9354-3_7
- Williams, K. D., Cheung, C. K. T., & Choi, W. (2000). Cyberostracism: Effects of being ignored over the internet. *Journal of Personality and Social Psychology*, 79(5), 748–762. <https://doi.org/10.1037/0022-3514.79.5.748>
- Williams, K. D., & Sommer, K. L. (1997). Social ostracism by coworkers: Does rejection lead to loafing or compensation? *Personality and Social Psychology Bulletin*, 23(7), 693–706. <https://doi.org/10.1177/0146167297237003>
- Williamson, T. J., Thomas, K. M. S., Eisenberger, N. I., & Stanton, A. L. (2018). Effects of social exclusion on cardiovascular and affective reactivity to a socially evaluative stressor. *International Journal of Behavioral Medicine*, 25(4), 410–420. <https://doi.org/10.1007/s12529-018-9720-5>