Sugar or Spice: Using I³ Metatheory to Understand How and Why Glucose Reduces Rejection-Related Aggression

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Published in: Aggressive Behavior, Volume 41, pages 537–543 (2015)
DOI: 10.1002/ab.21593

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Abstract

Social rejection can increase aggression, especially among people high in rejection sensitivity. Rejection impairs self-control, and deficits in self-control often result in aggression. A dose of glucose can counteract the effect of situational factors that undermine self-control. But no research has integrated these literatures to understand why rejection increases aggression, and how to reduce it. Using the I^3 model of aggression, we proposed that aggression would be highest under conditions of high instigation (rejection), high impellance (high rejection sensitivity), and low inhibition (drinking a beverage sweetened with a sugar substitute instead of glucose). As predicted, aggression was highest among participants who experienced social rejection, were high in rejection sensitivity, and who drank a placebo beverage. A dose of glucose reduced aggression, especially among rejected people high in rejection sensitivity. These findings point to the importance of self-control in understanding why social rejection increases aggression, and how to prevent it. (149 words)

Keywords: rejection; aggression; glucose; I^3 model; self-control

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Each day, people confront situations that trigger aggressive urges. We get insulted, frustrated, sniff foul odors, experience hot temperatures, and endure physical pain (Anderson & Bushman, 2002). Yet the base rate of aggression is quite low. Some scholars argue that we live in the most peaceful time in human history (Pinker, 2011). If the potential for daily aggression is high, then what helps keep aggression low?

Self-control is the tendency to override an urge to remain in agreement with standards for appropriate responses (Baumeister, Heatherton, & Tice, 1994). Self-control plays an integral role in shaping antisocial and aggressive behavior (Denson, DeWall, & Finkel, 2012). For example, self-control deficiencies increase aggression toward strangers and romantic partners (Finkel, DeWall, Slotter, Oaten, & Foshee, 2009; Stucke & Baumeister, 2006). Low self-control during childhood increases the odds of adult criminal conviction (Moffitt et al., 2011). Risk factors for aggression, such as angry rumination, increase aggression through reduced self-control (Denson, Pedersen, Friese, Hahm, & Roberts, 2011). One meta-analysis identified poor self-control as one of the "strongest known correlates of crime" (Pratt & Cullen, 2000, p. 952). Thus, poor self-control may help explain why people often behave aggressively because they become less motivated to override their aggressive urges.

If poor self-control contributes to rejection-related aggression, exposing people to a chemical that offsets self-control deficits may reduce it. A growing body of literature suggests that a dose of glucose can undo the negative consequences associated with self-control failure. Glucose levels predict performances on self-control tasks and consuming a glucose drink reduces self-control impairments (Gailliot et al., 2007; Gailliot & Baumeister, 2007). Whether people ingest or simply rinse their mouths with glucose (vs. a sugar substitute), they show less performance deficits in situations that normally undermine self-control (Hagger & Chatzisarantis, 2013; Molden et al., 2012). Neuroimaging evidence shows that a dose of

glucose increases activation in the ventral striatum and anterior cingulate cortex (ACC), which are regions that facilitate both reward and goal-directed behavior (Chambers, Bridge, & Jones, 2009) and might therefore set off the motivation to hold back aggressive urges.

It has been shown that rejection, an aversive state that is diametrically opposed to our fundamental need to belong (Baumeister & Leary, 1995) and strongly impacts psychological needs (Williams, Cheung, & Choi, 2000), impairs self-regulation—and this self-regulation failure is likely to disturb control behaviors, e.g. for socially undesirable impulses (Baumeister, DeWall, Ciarocco, & Twenge, 2005; Oaten, Williams, Jones, & Zadro, 2008). Thus, coping with rejection, people often behave aggressively: They allocate hot sauce to strangers (Warbuton, Williams, & Cairns, 2004) or punish others with aversive noise (Twenge, Baumeister, Tice, & Stucke, 2001); archival data even suggest that repeated rejection is related to school shootings (Leary, Kowalski, Smith, & Phillips, 2003). Aggressive people often experience social rejection, either from individuals or by society through imprisonment (Dishion, Patterson, & Griesler, 1994; Gottfredson & Hirschi, 1990). To earn acceptance and avoid rejection, people are often willing to regulate themselves, including their aggressive urges. But when people experience social rejection, they lose the motivation to control their impulses because they will not reap the benefits of social acceptance. Aggression, in contrast, is a rewarding behavior that may offer rejected people temporary pleasure by stimulating activation in the brain's reward centers (i.e., striatum, nucleus accumbens; Krämer, Jansma, Tempelmann, & Münte, 2007; Chester & DeWall, 2014). We propose that the drop in self-control may help explain the paradoxical and reliable finding that social rejection often increases aggressive urges and behaviors, even though prosocial tendencies would be more functional (e.g., Gaertner, Iuzzini, & O'Mara, 2008; Twenge et al., 2001). Hence, we hypothesized that a dose of glucose would reduce the relationship between rejection and aggression.

Who might benefit most from a dose of glucose? Rejection sensitive people represent one possibility. Rejection sensitivity refers to the tendency to anxiously expect and react strongly to rejection (Downey & Feldman, 1996). Some evidence suggests that rejection sensitive people behave most aggressively when rejected (Ayduk, Gyurak, & Luerssen, 2008; but see Buckley, Winkel, & Leary, 2004). Other work suggests that factors associated with good self-control, such as delay of gratification, buffer rejection sensitive people from aggression (Ayduk et al., 2000). We predicted that aggression would be highest when rejection sensitive people experienced social rejection and did not receive a dose of glucose. Because rejection sensitive people are most prone to aggressive outbursts in the wake of rejection, a dose of glucose should have the strongest effect in motivating them to override their aggressive urges. As social acceptance does not stimulate an aggressive urge in need of being overridden, self-control processes should not influence accepted people's aggression.

Our predictions conform to the I^3 metatheory of aggression (Finkel, 2014; Finkel et al., 2012). I^3 metatheory uses principles of statistical moderation to provide a coherent conceptual framework to understand processes underlying aggression. This theory argues that the likelihood of aggression waxes and wanes according to the combination of factors related to instigation, inhibition, and impellance (thus the three *I*s in I^3 metatheory): Instigation is the exposure to behaviors that trigger an urge to aggression, e.g. rejection; inhibition is a dispositional or situational factor that increases the likelihood that people will override this urge, e.g. low glucose; and impellance is a dispositional or situational factor that prepares an individual to experience a strong urge to aggress, e.g. high rejection sensitivity (Finkel, 2014; Finkel et al., 2012). According to Perfect Storm Theory that is derived from the I^3 model, the intensity of aggressive behavior is much higher when instigation and impellance are strong and inhibition is weak compared to "any of the situations formed by the other seven possible combinations" (Finkel, 2014, p. 33). The reason this is the preferred comparison is that it offers the most opportunities for falsification (Popper, 1959).

Consistent with I^3 metatheory, we therefore predicted that aggression would be highest under conditions of high instigation (rejection vs. acceptance), low inhibition (a dose of a sugar substitute vs. a dose of glucose), and high impellance (high vs. low rejection sensitivity).

Method

Participants and design

110 German undergraduates (80 female, 30 male; M_{age}=24.95, SD_{age}=7.74) were randomly assigned to a 2 (inclusionary status: rejection vs. acceptance; *instigator*) x 2 (beverage: glucose vs. placebo; *inhibitor*) between-subject design; rejection sensitivity (*impellor*) served as continuous moderator variable. Participants were not allowed to participate if they reported intolerances to sugar, saccharine, or citrus fruits. We chose our sample size by aiming to recruit at least 25 participants per condition. Prior research on the relationship between social rejection and aggression suggested that this sample size would provide adequate statistical power (Twenge et al., 2001). We stopped data collection according to the end of the academic term in which the data were collected.

Materials

Rejection sensitivity. Participants judged nine scenarios on rejection sensitivity (A-RSQ; Berenson et al., 2009; e.g., *You ask your parents or another family member for a loan to help you through a difficult financial time*). They reported feelings of concern regarding the other person's reaction (e.g., *How concerned or anxious would you be over whether or not your family would want to help you?*) and their anticipated reaction of the person (e.g., *I would expect that they would agree to help as much as they can*) on 1=very unconcerned/very unlikely to 6=very concerned/very likely response scales. According to the suggestions of Downey and Feldman (1996), we multiplied level of rejection concern (α=.77) by the reverse level of acceptance expectancy (α=.67) for each scenario and computed a mean rejection sensitivity score (α=.81, based on the raw scores).

Beverage. Participants drank 11.16 ounces of a soft drink that was either sweetened with sugar (7 Up; glucose condition) or a sugar substitute (7 Up Light; placebo condition). The glucose drink contained 140 calories, whereas the placebo drink contained 0 calories. Because participants consumed the beverage (instead of swishing it in their mouths), we allowed twelve minutes for participants to wait in order for the glucose to metabolize.

Drink liking. Participants completed two measures of liking for the drink on 1=not at all to 5=very much response scales (*How much do you like the flavor "sweet"?*; *How much did you enjoy the beverage?*).

Basic needs. Rejection threatens specific fundamental needs (Williams et al., 2000). Thus, as manipulation check for the rejection manipulation participants responded to 20 items on 1=not at all to 5=very much response scales measuring sense of belonging (e.g., *I feel "disconnected"*), self-esteem (e.g., *I feel good about myself*), control (e.g., *I feel invisible*), and meaningful existence (e.g., *I feel powerful*) which were combined to create an overall need fulfilment scale (α=.79; based on Jamieson, Harkins, & Williams, 2010).

Aggression. To measure aggression, we used the well-validated hot sauce paradigm (Lieberman, Solomon, Greenberg, & McGregor, 1999). Participants were told that they would prepare a food sample for another participant who expressed disliking for "hot" food. They could give as much or little hot sauce as they wished. We measured hot sauce weight using a precision scale (*M*=5.95 g, *SD*=5.86; range: 3.38-45.77 g).

Procedure

Participants arrived at the laboratory for a study ostensibly assessing the relationship between flavor and emotions. They were told that the study would consist of a single and a group session with a total of four participants taking part simultaneously. After completing informed consent, participants responded to the rejection sensitivity scale. Next, they consumed either the glucose or placebo beverage (by random assignment) whereby participants were blind to the conditions. The experimenter then informed participants that

they would work with three other participants on an upcoming group task, in which participants chose with whom they would like to work. To form an opinion, faked evaluations of the rejection sensitivity questionnaires purportedly filled in from other participants were given to the participant. The experimenter also collected the participant's questionnaire to give its evaluation to the alleged others. The faked evaluations were presented as profile lines that contained levels of helpfulness, friendliness, ability to compromise, openness, and cooperativeness; each of the three profile lines had the same average value of 3.20 and ranged on 5-point scales between 2 and 4. After 2 min, the experimenter returned and delivered the social rejection manipulation. By random assignment, half of the participants were told no one chose them (rejection condition), whereas the other half of the participants were told everyone chose them (acceptance condition). Participants then completed the need fulfilment measure. Next, they completed the aggression task: Participants were told to pour hot sauce into a cup that one of the other participants should eat as part of the following group study. Finally, participants were debriefed and thanked.

Results

A full reporting of our descriptive statistics and results can be found in Tables 1 and 2.

Manipulation check. Consistent with numerous studies, rejected participants (M=3.40, SD=0.43), compared to accepted participants (M=3.63, SD=0.47), reported lower need fulfillment, $t(102)$=-2.59, p=.011, d=-0.51, 95%CI=[-0.90,-0.15]. Participants in the glucose and placebo conditions also rated the beverages as equivalent in terms of enjoyment and preferred the flavor 'sweet' similarly, ps>.401. As our rejection manipulation was based on ostensible evaluations of the rejection sensitivity questionnaire, we examined the possibility that participants high in rejection sensitivity would have had a more severe rejection experience than participants low in rejection sensitivity. We used Hayes' (2012) PROCESS tool entering inclusionary status (dummy coded as +1=rejection and -1=acceptance), as well as rejection sensitivity (standardized) as independent variables and need fulfillment as the

dependent variable. The analysis revealed no significant interaction, b=0.07, SE=0.04, t(100)=1.57, p=.119, indicating no difference in the rejection experience.

Aggression. We predicted that aggression would be greatest at high levels of instigation (i.e., rejection), low levels of inhibition (i.e., placebo beverage), and high levels of impellance (i.e., high rejection sensitivity). We used Hayes' (2012) PROCESS tool entering inclusionary status (dummy coded as +1=rejection and -1=acceptance), beverage (dummy coded as +1=glucose and -1=placebo), as well as rejection sensitivity (standardized) as independent variables and amount of hot sauce (log transformed) as dependent variable. There was a main effect of inclusionary status, such that rejected participants (M=1.73, SD=0.58) behaved more aggressively than accepted participants did (M=1.48, SD=0.28), b=0.13, SE=0.04, t(102)=3.06, p=.003, 95%CI=[0.05,0.22]. Neither beverage condition, b=-0.01, SE=0.04, t(102)=-0.26, p=.794, nor rejection sensitivity, b=0.07, SE=0.04, t(102)=1.59, p=.115, showed significant main effects.

As predicted, we observed a significant three-way interaction between inclusionary status, beverage, and rejection sensitivity, b=-0.11, SE=0.04, t(102)=-2.48, p=.015, 95%CI=[-0.20,-0.02], with a power at α=.05 of .66. Among participants relatively high in rejection sensitivity (i.e., 1 standard deviation above the mean), there was a significant inclusionary status by beverage interaction, b=-0.14, SE=0.06, t(102)=-2.27, p=.025, 95%CI=[-0.26,-0.02]. When these participants experienced social rejection (vs. acceptance), they behaved more aggressively if they drank the placebo beverage, b=0.34, SE=0.09, t(102)=3.88, p<.001, 95%CI=[0.17,0.51], compared to if they drank the glucose-laden beverage, b=0.06, SE=0.09, t(102)=0.73, p=.466. In contrast, there was no significant interaction between inclusionary status and beverage among participants relatively low in rejection sensitivity, b=0.09, SE=0.61, t(102)=1.28, p=.293. Further simple slope analyses within the rejection condition revealed that, whereas under glucose participants high and low in rejection sensitivity did not differ, b=-0.09, SE=0.10, t(57)=-0.89, p=.377, under placebo participants high in rejection

sensitivity gave more hot sauce than participants low in rejection sensitivity, *b*=0.37, *SE*=0.12, *t*(57)=3.13, *p*=.003, 95%CI=[0.13,0.60], see Figure 1.

According to I^3 metatheory, the combination of high instigation, low inhibition, and high impellance creates a "perfect storm" effect, in which the likelihood of aggression is highest (Finkel, 2014). To test this hypothesis, we conducted a planned contrast analysis that compared aggression among highly rejection sensitive participants (1 *SD* above mean) who experienced rejection and who drank the placebo beverage against the average aggression levels of all other participants combined (dummy coded as +1=perfect storm condition and -1=not perfect storm condition). As expected, a hypothetical participant in the perfect storm situation (*M*=2.25, *SD*=0.96) behaved substantially more aggressively than an average participant in the other seven situations (*M*=1.58, *SD*=0.43), *t*(108)=3.18, *p*=.002, *d*=1.45, 95%CI=[0.53,2.37]. Put another way, the perfect storm situation, compared to the average of the seven comparison conditions, increased aggression by 143%.[1]

Discussion

When people experience the pain of rejection, why do they often behave aggressively? Such aggression represents a paradox: Rejection increases the motivation to affiliate, but behaving aggressively will likely result in further rejection. Our findings suggest that self-regulation failure may underlie the relationship between social rejection and aggression. Compared to participants who drank a glucose-laden beverage, those who drank a beverage sweetened with a sugar substitute behaved more aggressively in the wake of social rejection. Consistent with the I^3 metatheory of aggression (Finkel, 2014), this effect was most pronounced among highly rejection sensitive participants. In other words, aggression was highest at high levels instigation (social rejection), low levels of inhibition (sugar substitute beverage), and high levels of impellance (high rejection sensitivity). Aggression is a rewarding behavior that activates pleasure centers of the brain, such as the striatum and the nucleus accumbens (Chester & DeWall, 2014; Krämer et al., 2007). Glucose produces a

similar effect, with one crucial exception: in addition to stimulating reward centers, glucose increases neural activation in brain regions that aid self-regulation (Chambers et al., 2009), which is likely the underlying mechanism to our findings.

Prior research suggests that socially rejected people behave aggressively toward both the rejectors and innocent bystanders (e.g., Twenge et al., 2001). Hence, our effects should replicate if our rejected participants were given the opportunity to behave aggressively toward someone uninvolved in the rejection experience. Crucially, however, the key factor is whether the target of aggression represents a potential source of renewed affiliation (see DeWall & Bushman, 2011). In our study, participants were not given any indication that the source of their aggression represented a potential friend. Hence, they behaved quite aggressively unless they received a chemical that would motivate them to override their aggressive urges. Had we told rejected participants that they would have a chance to befriend the target of their aggression, they would have regained their motivation to behave in a prosocial manner because doing so could earn them social acceptance. Although, in our study the comparison condition represented social acceptance and not a neutral state, we expect that our findings would replicate had we used a neutral control condition: Previous research (e.g., Wesselmann, Bagg, & Williams, 2009), sociometer theory (Leary, 1999), and also everyday observations suggest that we usually are surrounded by people who accept us. Hence, people often assume that they will be included, which is in line with many previous studies that demonstrate no significant differences between social acceptance conditions and neutral control conditions (Baumeister et al., 2005; Twenge et al., 2001). Our participants ingested the glucose beverage, however, recent evidence suggests that simply swishing the beverage in their mouths would have also reduced their aggression (the gargle effect; Sanders, Shirk, Burgin, & Martin, 2012). Future research would benefit from a conceptual replication of our findings that compares ingesting glucose with a delay and simply gargling glucose. It should moreover be noted that our sample size is quite small to detect 3-way interactions. Future research using

bigger sample sizes could strengthen confidence in our findings. It would also be a valuable addition for further research to control for dispositional levels of self-control.

This work has several theoretical implications. First, it demonstrates the predictive utility of I^3 metatheory of aggression (Finkel, 2014; Finkel et al., 2012). Second, it represents the first replication of an interaction between social rejection and rejection sensitivity on aggression (Ayduk et al., 2008). Third, it links another related factor, namely glucose, to the interactive effect of social rejection and rejection sensitivity on aggression.

Understanding the constellation of factors that underlie aggression can aid the design of effective interventions aimed at reducing aggression. Maintaining a shore of psychological energy, whether through eating fruits or a spoonful of sugar, should help people override their aggressive urges.

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Footnote

[1] To compare aggression among participants in the perfect storm condition against the average aggression levels of all other *rejected* participants combined, we conducted another planned contrast analysis. It revealed that a participant in the perfect storm situation (M=2.25, SD=0.96) behaved substantially more aggressively than an average rejected participant in the other three situations (M=1.68, SD=0.52), $t(56)=2.17$, p=.035, d=1.01, 95%CI=[0.07,1.94].

Table 1

Descriptive statistics, reliability coefficients and correlations for the study variables

Variable	*M*	*SD*	1	2	3	4	5
1. Rejection sensitivity	7.71	3.61	(.81)				
2. Drink liking (a)	4.32	0.83	-.06				
3. Drink linking (b)	3.35	0.91	.05	.41***			
4. Basic needs	3.51	0.46	-.33**	.10	.02	(.79)	
5. Aggression	5.95	5.86	.11	-.14	-.06	-.11	
6. Aggression (log)	1.61	0.48	.10	-.17	-.04	-.20*	.91***

Note. Reliability coefficients (Cronbach's alpha) are listed in the diagonal. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 2

Results for the multiple regression with inclusionary status, substance, rejection sensitivity, and all interaction terms as predictors of hot sauce allocation (log)

	Unstandardized regression coefficients (*b*)	Standard error for *b* estimates (*SE*)	*t*	*p*	f^2
Inclusionary status	0.13	.04	3.06	.003**	.080
Beverage	-0.01	.04	-0.26	.794	.001
Rejection sensitivity	0.07	.04	1.59	.115	.020
Inclusionary status x beverage	-0.03	.04	-0.71	.479	.004
Inclusionary status x rejection sensitivity	0.07	.04	1.62	.109	.021
Beverage x rejection sensitivity	-0.12	.04	-2.73	.007**	.063
Inclusionary status x beverage x rejection sensitivity	-0.11	.04	-2.48	.015*	.052

Note. * $p < .05$, ** $p < .01$

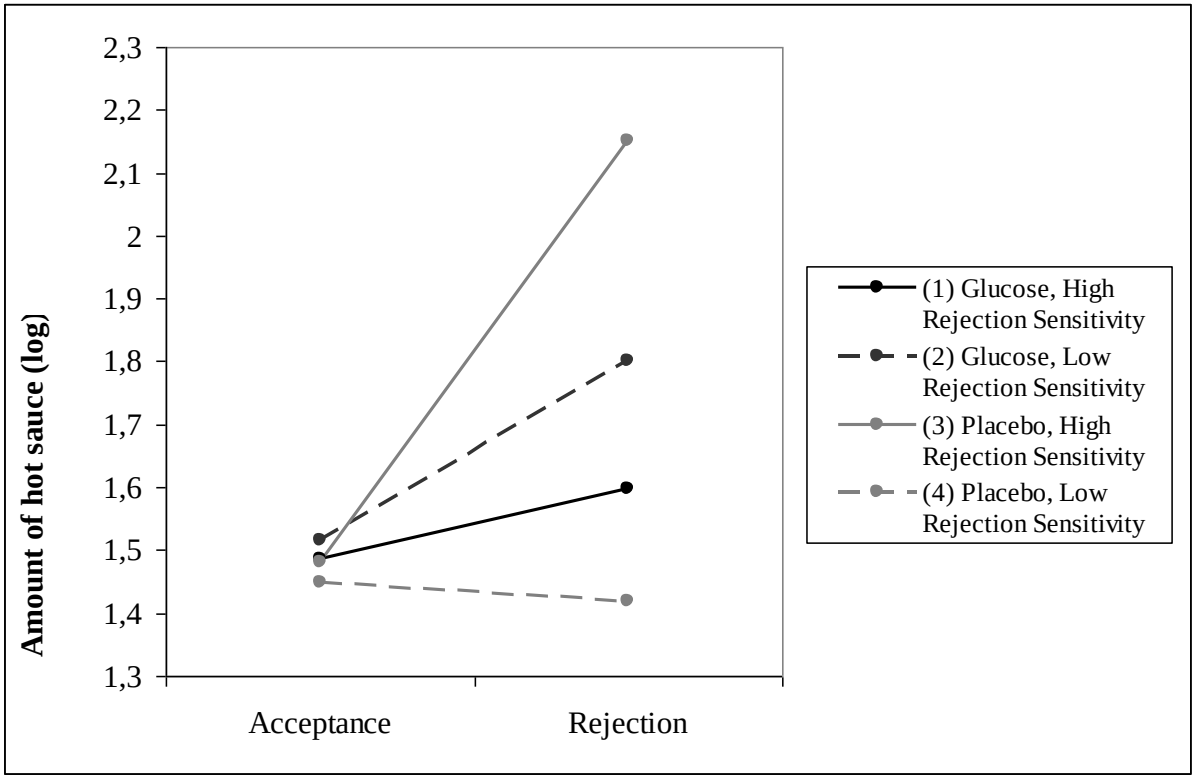

Figure 1. Hot sauce allocation (log) as a function of beverage (glucose vs. placebo), inclusionary status (rejection vs. acceptance), and rejection sensitivity (plotted at 1 *SD* above vs. below the mean).