Emotion

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The Anger-Infused Ultimatum Game: A Reliable and Valid Paradigm to Induce and Assess Anger

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The Ultimatum Game (UG) is a canonical social decision-making task whereby a proposer divides a sum of money between himself and a responder who accepts or rejects the offer. Studies consistently demonstrate that unfair offers induce anger, and that rejecting such offers relates to aggression. Nevertheless, the UG is limited in interpersonal provocations common to real-life experiences of anger. Moreover, the psychometric properties of the UG as an anger-induction paradigm have yet to be evaluated. Here, to induce a more intense and genuine anger experience, we implemented a modified UG whereby short written provocations congruent with unfairness levels accompanied each offer. We aimed to test whether this anger-infused UG led to more anger and aggressive responses relative to the standard UG and to establish the reliability and validity of both versions. Participants performed either the anger-infused UG or a standard version, repeated twice, a week apart. They also performed the Taylor Aggression Paradigm, a reactive aggression paradigm, and completed emotion ratings and a trait anger inventory. Results indicate similar decreases in acceptance rates with increase in offer unfairness, and increases in reported anger, across both UG versions. Both versions demonstrated strong test–retest reliability. However, the anger-infused UG led to significantly stronger relations with reactive aggression and trait anger compared to the standard UG, providing evidence for better validity. The development of the anger-infused UG as a reliable and valid paradigm is pivotal for the induction and assessment of interpersonal anger and its aggressive expression in basic and clinical research settings.

Keywords: anger, aggression, Ultimatum Game, Taylor Aggression Paradigm, trait anger

Supplemental materials: http://dx.doi.org/10.1037/emo0000435.supp

Anger is a ubiquitous human phenomenon. It is commonly aroused during social interactions that involve violation of social norms and personal insults that are perceived as intentional unfair slights or malicious demeaning offenses toward one's personal identity (Averill, 1983; Fehr, Baldwin, Collins, Patterson, & Benditt, 1999; Gilam & Hendler, 2015; Lazarus, 1991; Miller, 2001). Aggression is the prototypical behavioral manifestation of anger in reaction to such provocations, potentially leading to costly conse-

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quences, both for the individuals involved in the situation as well as for society in general (Berkowitz & Harmon-Jones, 2004; Blair, 2012; Davidson, Putnam, & Larson, 2000; Rosell & Siever, 2015). Importantly, unbalanced and dysregulated anger is prevalent in numerous psychiatric conditions, underscoring its role in psychopathology (Fernandez & Johnson, 2016; Novaco, 2010). This emphasizes the need for psychometrically sound experimental paradigms that will allow for the elicitation and assessment of the anger construct in an interpersonal context, while also examining its aggressive manifestation, in basic and clinical research.

The Ultimatum Game (UG; Güth, Schmittberger, & Schwarze, 1982) presents a simple bargaining situation between two players. The first player decides how to split a sum of money between himself and a second player, who in turn decides whether to accept or reject the offer. If accepted, both players receive the designated payoff, but if rejected, both players end up with nothing. Findings repeatedly show that individuals tend to reject more offers as the proportion of the sum offered to them decreases, thus willing to sacrifice some financial profit over accepting offers deemed unfair (Cooper & Dutcher, 2011; Gabay, Radua, Kempton, & Mehta, 2014). Numerous studies have shown that being offered such unfair offers elicits negative emotions, especially anger, which then holds a pivotal role in mediating their rejection (e.g., Grecucci, Giorgetta, van't Wout, Bonini, & Sanfey, 2013; Pillutla & Murnighan, 1996; Srivastava, Espinoza, & Fedorikhin, 2009; Vögele, Sorg, Studtmann, & Weber, 2010; Xiao & Houser, 2005). Moreover, the rejection itself is considered an aggressive expression of the induced experience of anger (e.g., Burnham, 2007; Crockett et al., 2013; Mehta & Beer, 2010; Yamagishi et al., 2009, 2012). In this regard, the UG has been successfully applied in various clinical settings (e.g., Koenigs & Tranel, 2007; White et al., 2015).

The standard UG presents a social situation in which there is interdependency between two people, and the experimental separation between the offer phase and the decision phase makes it a suitable paradigm for inducing anger and examining its aggression-related behavioral consequences, respectively. Nevertheless, the psychometric properties of the UG have yet to be established, potentially hampering its application to the study of anger. Furthermore, evidence suggests that anger during the UG is elicited by the unfairness quality of offers, but the task is limited in the fundamental interpersonal provocations that are typical of real-life angering social interactions, such as insults, threats, and violations of basic norms of conduct (Berkowitz & Harmon-Jones, 2004; Gilam & Hendler, 2015; Kuppens, Mechelen, Smits, De Boeck, & Ceulemans, 2007). More realistic paradigms in the experimental study of human emotions are necessary for ecological validity, allowing for a more comprehensive study of the genuine experience and expression of emotions in healthy as well as in pathological conditions (Fischer & Van Kleef, 2010; Gilam & Hendler, 2016; Müller-Pinzler, Krach, Krämer, & Paulus, 2016). To bridge these gaps, we recently embedded interpersonal provocations within the framework of the UG to evoke an authentic angering social interaction by having participants playing as responders verbally negotiate with an intentionally confrontational confederate proposer, during functional MRI (fMRI; Gilam et al., 2015). We observed an inverse relationship between reported levels of anger and offer acceptance rates that was modulated by brain activity in the ventro-medial prefrontal cortex (vmPFC), a key region implicated in emotion regulation (Etkin, Büchel, & Gross, 2015). In further support of the utility of infusing anger in the UG, we were subsequently able to predict, in a subsample of soldiers, the increase in traumatic stress symptoms based on their level of vmPFC activation during these angering unfair offers (Gilam, Lin, Fruchter, & Hendler, 2017).

In the current study, in an effort to facilitate and standardize the administration of an interpersonal, anger-infused version of the UG, we created a version embedded with short, written interpersonal provocations that accompanied each offer. Our first aim was to test whether this anger-infused version would yield a more intense anger experience in terms of the primary behavioral (offer acceptance rates) and emotional (subjective reports) measures of the task, relative to a standard UG task. Second, to address the current need in the UG literature, we aimed to establish the psychometric properties of both the standard and the anger-infused UG as anger-induction paradigms, specifically in terms of test–retest reliability and convergent validity. To these ends, we carried out a between-subjects design in which participants performed either the anger-infused or the standard version of the UG, each repeated in two separate experimental sessions about a week apart. Validity was examined by testing the association between the primary outcome measures of the UG and both trait anger scores (Spielberger, 1999) and outcome measures (noise-blast intensities) in the Taylor Aggression Paradigm (TAP), a hallmark paradigm assessing reactive aggression (Giancola & Parrott, 2008; Giancola & Zeichner, 1995). In fact, the TAP, which we administered following the UG, similarly engages the vmPFC in facilitating nonaggressive behavior (Beyer, Münte, Göttlich, & Krämer, 2015), supporting the expected relationship to the UG. To examine the test–retest reliability of the UG, we tested correlations of the main outcome measures between the first and second time it was administered. We hypothesized that participants who performed the anger-infused UG will reject more unfair offers and report more anger compared to those who performed the standard version of the UG. We also hypothesized that the anger-infused version would exhibit more robust reliability and validity in terms of anger induction.

Materials and Method

Participants

One hundred and nineteen participants (72 females, age range 18–43 years), recruited from Tel Aviv University campus and social media advertisements, performed the experiment for course credit or as volunteers. All participants completed secondary education and performed both experimental sessions within a range of 6–12 days. The study was approved by the Institutional Ethics Committee of Tel Aviv University, and written informed consent was obtained from all participants.

Participants were randomly allocated to one of the two experimental groups, namely the standard ($n = 59$) or the infused ($n = 60$) version of the UG. Sample size was aimed for about $n = 50$ in each UG version, similar to previous UG studies (e.g., Duek, Osher, Belmaker, Bersudsky, & Kofman, 2014; Halali, Bereby-Meyer, & Ockenfels, 2013). No differences were found between the two UG versions in terms of gender distribution (32 and 27 females, respectively), age ($M = 25.52 \pm 4.63SD$ and $M = 27.14$

± 6.14 years, respectively), number of days between experimental sessions ($M = 7.24 \pm 0.88$ and $M = 7.30 \pm 1.11$ days, respectively), number of participants receiving course credit (42 and 39 participants, respectively), all ps >0.11. Eleven additional participants were discarded: four due to deviation in age (>2.5 *SD* above mean), two did not return to complete the second session of the experiment, two failed to comprehend instructions, and three expressed explicit disbelief in receiving offers from real people.

General Procedure

Each study session was divided into several phases (Figure 1A) beginning with a thorough explanation of the rules of the UG (extensively detailed in supplementary material), presented on a computer screen. Participants were told they would be playing as responders to offers in varying sums ranging between 20 and 30 Israeli New Shekels (ILS; approximately 5.5–8.5 USD) randomly drawn from a database of offers given by previous participants. They were also told that the three highest earning participants would receive their actual monetary earning at the end of data collection. Along the instructions they answered comprehension control-questions and then completed the instructions by practicing the sequence and timing of an equal-split offer. Immediately after, participants provided their own offer to be supposedly added to the database of offers. Participants allocated to the anger-infused UG were also required to write a short message (up to 35 characters) to accompany their offer.

In the next phase, participants were asked to rate their motivation ("To what extent do you want to win money in the game?") and subjective value of money ("To what extent do you value 10 ILS?"), on a 0 (not at all) to 10 (very much) scale. These questions enabled us to control for motivational engagement and subjective value in both experimental sessions, and to verify that these measures did not differ between the UG groups. Indeed, no differences were found between groups or sessions, ps > 0.16, in terms of motivation (overall $M = 6.67 \pm 2.66$) or subjective value (overall $M = 5.48 \pm 2.39$). Participants were next asked to report on their current emotional state by rating four emotion categories, namely anger, fear, happiness, and sadness, on a similar 0–10 scale.

Providing participants with several emotion categories prevented them from being driven directly toward anger, and allowed to assess other emotion categories potentially relevant to the UG (e.g., Chapman, Kim, Susskind, & Anderson, 2009; Riepl, Mussel, Osinsky, & Hewig, 2016). We also expected to replicate our previous findings (Gilam et al., 2015) indicating that the induction of emotion by the UG is not a mere negative mood induction in which all negative emotions increase, but specific to anger. These specific emotion categories were also chosen because of their similarities and differences as far as arousal, valence, and motivational tendency (Berkowitz & Harmon-Jones, 2004; Carver, 2004; Carver & Harmon-Jones, 2009; Lazarus, 1991; Russell, 1980); anger is considered high arousal, negative valence, and approach motivation; fear is considered high arousal, negative valence, and avoid motivation; happiness is considered high arousal, positive valence, and approach; and sadness is considered low arousal, negative valence and approach.

Next, participants performed the UG task according to their group assignment, as detailed below. Upon completion, participants were asked again to report on their current emotional state, as well as rate the same four emotion categories and fairness perception in relation to three types of offers in the UG (fair, medium, and unfair, as detailed below) using the same 0–10 scale. The order of all subjective ratings, before and after the UG, as well as of the three exemplary offers, was presented randomly across participants.

The next phase of the experiment required participants to perform the TAP. The TAP was presented as an online interactive game versus another participant. To increase credibility, a phone call was placed to another experimenter, supposedly synchronizing the start of the game. After the ostensible confirmation was witnessed by the participant, the TAP was performed as detailed below. Following the TAP, participants were asked again to report on their current emotional state as described above. The first experimental session ended at this point; the second experimental session also included the assessment of trait anger and a debriefing questionnaire to inquire whether participants reported suspicions of the various manipulations and subsequently full disclosure of the experiment was performed. As detailed below, two sets of tasks were available both for the UG and for the TAP which were counterbalanced across experimental sessions, and the order of the two sets was randomized across participants. Each experimental session lasted approximately 45 min.

Ultimatum Game (UG)

Both standard and anger-infused UG versions were analogous to a typical UG in which participants responded to multiple offers previously made by various putative proposers, supposedly other participants of the experiment. All offers were in fact predetermined and were defined as fair (responder is offered 40%–50% of the total sum), medium (25%–35% of the total, or unfair (10%–20% of the total) offers. In order to examine the test–retest reliability of the UG, we created two equivalent sets of offers, both balanced in terms of the total sum of money across offers (276 ILS) and average difference between offers. Each set had a total of 36 offers, 12 of each offer type (Table S1).

Each offer trial was divided into four phases (Figure 1B), beginning with a short (randomly generated between 2 and 4 s) fixation cross presented at the center of the screen. An offer was next presented (5 s) with the name initials of the putative participant giving the offer, followed by a decision phase (5 s) in which participants used a keyboard button press to accept or reject the offer. Finally, the result of the decision was presented (2 s): If it was accepted, the money was shown split between the players according to the offer, and if it was rejected, "0" was shown for each player. Participants were informed before the task to make their decisions intuitively and quickly and that if the response would not be within a given time limit, the offer would be considered as a rejection. Within each offer type, coupling between specific offers and name initials (and in the anger-infused version, also the interpersonal messages) was randomized across participants, as was the order of presented offers.

The only difference between the standard UG and the anger-infused UG was that the latter included short interpersonal messages. While these messages were presented to participants as a general way of proposers to communicate with their counterparts, these messages were in fact aimed at further inducing interpersonal

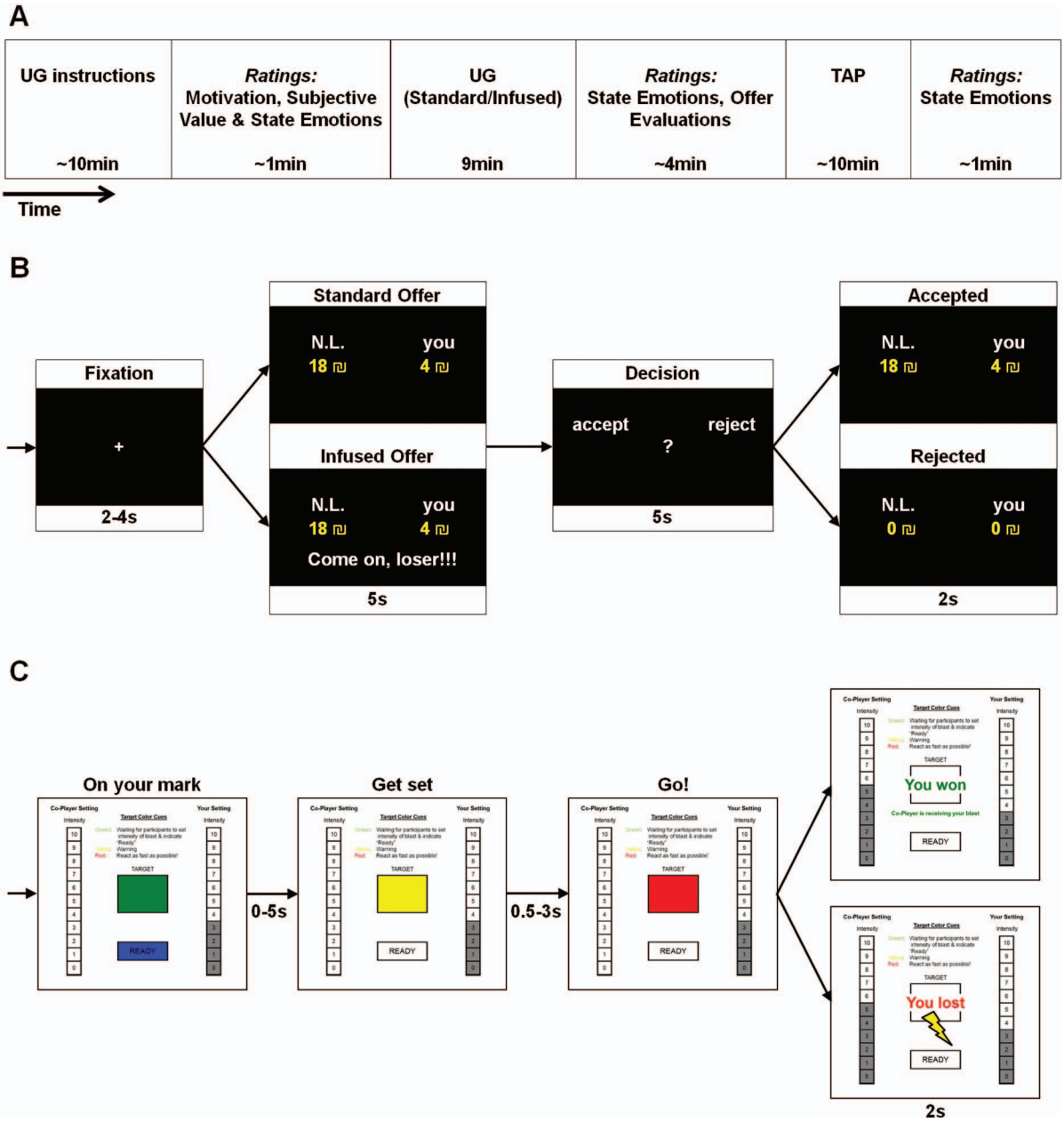

Figure 1. Study design, Ultimatum Game and Taylor Aggression Paradigm. (**A**) In both experimental sessions, participants began with Ultimatum Game (UG) instructions followed by ratings of state emotions (Anger, Fear, Sadness and Happiness) and control questions and completing either the Standard or the Anger-Infused versions of the UG. Subsequently, they rated state emotions again and rated emotions and fairness evaluations per offer type (Fair, Medium, and Unfair). Finally participants were administered the Taylor Aggression Paradigm (TAP) and rated state emotions one final time. (**B**) Sequence of one trial in the UG. Each round began with a short fixation period, supposedly the time in which the computer draws offers from the pool of previous putative participants. A randomly drawn offer is presented, coupled with an interpersonal message in the case of the anger-infused version. Participants then had to decide whether to accept or reject the offer and then viewed the result of their decision. This sequence was repeated 36 times in total. (**C**) Sequence of one round in the TAP. After participants chose the noise-blast intensity inflicted upon their opponent if they won the round and pressed a "ready button," the target at the center of the screen turned green (black). The target changed to yellow (light gray) as soon as the putative competitor also pressed their "ready' button, indicating the competition was about to begin. Once the target color changed to red (dark gray), participants had to press the mouse button as quickly as possible. Finally, the winner was declared allegedly based on the shortest reaction time. If the participant lost the round, the noise-blast intensity chosen by their opponent was heard through headphones for two seconds. See the online article for the color version of this figure.

anger in the responders. The messages were congruent with the offer type—fair offers were accompanied by nonconfrontational, low-angering messages (e.g., "let's split it equally"), while medium and unfair offers were accompanied by ever growing insults and threats (e.g., "That's the offer, deal with it" and "Come on, loser!!!" respectively; Table S2). A pilot study was conducted to validate the angering quality of the interpersonal messages (see details in supplementary materials).

Taylor Aggression Paradigm (TAP)

The TAP was previously shown to be a psychometrically sound task to measure reactive aggression by the level of aversive noise intensity supposedly administered to an opponent in a reaction time (RT) competition (Beyer et al., 2015; Giancola & Parrott, 2008; Giancola & Zeichner, 1995). During the task, participants were led to believe they were playing against a real opponent, supposedly an additional participant, both competing to respond as quickly as possible (using a computer mouse) when a target on the screen turned red. At the end of each of 10 rounds (Figure 1C, and extensively detailed in supplementary materials), the winner was declared and the level of noise intensity chosen by each player is revealed. In parallel, the player who lost the round heard (through headphones) the noise blast at the intensity chosen by their supposed opponent, for two seconds.

To provoke interpersonal anger and aggression, the noise level set by the putative competitor was predetermined to increase gradually along the 10 rounds, and participants always lost the first and last rounds, while they randomly won 50% of the remaining rounds. Due to a technical problem in volume modulation, data for 41 participants (21 from the standard UG version and 20 from the infused UG version) were discarded, leaving a total of 78 participants with valid TAP data (40 in the anger-infused UG and 38 in the standard UG).

Trait Anger Assessment

Trait anger, an individual's habitual tendency to experience anger, was assessed using the gold-standard State-Trait Anger Expression Inventory-2 (Spielberger, 1999). The trait anger scale comprised 10 items rated on a 4-point scale from 1 (*not at all*) to 4 (*very much*) related to the frequency of angry feelings experienced over time. Trait anger was calculated as the sum score of these items and showed an internal consistency of Cronbach's alpha = .79. No difference was found in trait anger scores between the standard and anger-infused groups of participants ($M = 20.19 \pm 4.16$ and $M = 20.47 \pm 4.70$, respectively; $p = .73$).

Data Analysis

First, we examined whether the primary behavioral and emotional measures of the UG differed between UG versions. To this end, offer acceptance rates, total gain in the task, and emotion and fairness ratings were each submitted to a separate repeated-measures analysis of variance (ANOVA) testing these factors (detailed below), and with Version (Standard, Anger-Infused) as a between-subjects factor.

To assess the convergent validity of the UG, and contrast the UG versions, we examined performance in the TAP and tested the associations between the primary outcome measures of the UG and trait anger. Behavior in the TAP was tested using a repeated-measure ANOVA of noise blast intensity, with UG Version (Standard, Anger-Infused) as a between-subjects factor. Next, we examined whether trait anger scores correlated with the primary measures of the UG. We focused on total gain in the UG due to its better precision in capturing individual differences in UG behavior (e.g., one who accepted 13:14 and 9:19 offers has a different gain but equal acceptance rate compared with one who accepted 12:13 and 7:17 offers), self-reported anger to the unfair offers (which represent the most angering condition of the UG), and the increase in self-reported anger elicited by the task (Δanger). Differences between the UG version in the magnitudes of these correlations was then tested using the Fisher transformation.

Finally, we examined the test–retest reliability of the primary measures of the UG. This was conducted first by calculating the correlation for each measure between the first and second time that the task was completed. Correlations were calculated separately for each UG version, and then tested for differences. Second, we entered each measure into a repeated-measures ANOVA that included Time (Session 1, Session 2) as a within-subject factor and UG Version (Standard, Anger-Infused) as a between-subjects factor.

All analyses were repeated using Set Order (A-B, B-A) as a between-subjects factor to test for possible differences associated with this factor. No significant main or interaction effects emerged, suggesting that the reported effects were not due to differences between UG sets or TAP sets. Significant higher-order ANOVAs were decomposed by lower-order ANOVAs; effect sizes were reported using η_p^2 (ANOVA) and Cohen's d (t tests). All hypotheses were two-sided, and a significance level of $\alpha \leq .05$ was used to detect effects.

Results

Primary Measures of the UG

Offer acceptance rate and total gain. Acceptance rates in the task were submitted to a repeated-measures ANOVA with Offer Type (Fair, Medium, Unfair) as a within-subject factor, and Version (Standard, Anger-Infused) as a between-subjects factor. This analysis revealed, in line with previous UG findings, a significant main effect of Offer Type, $F(2, 234) = 341.48$, $p < .001$, $\eta_p^2 = 0.75$, with follow-up analyses indicating decreasing acceptance rates with unfairness of offers (Fair: $M = 93.7 \pm 14.1\%$, Medium: $M = 43.6 \pm 35.8\%$, Unfair: $M = 19.0 \pm 32.8\%$; see Figure 2A), $ps < 0.001$. Unlike our hypothesis, no main or interaction effects of Version emerged, $ps > 0.47$, indicating that the pattern of offer acceptance did not differ between UG versions. Similarly, a univariate ANOVA performed on total gain in the task indicated no significant main effect of Version, $F(1, 117) = 0.80$, $p = .37$, $\eta_p^2 = 0.01$.

Emotion and fairness rating to offers. To examine the intensity of emotions elicited in response to the different offer types, we submitted emotion ratings provided following the task to a repeated-measures ANOVA with Offer Type (Fair, Medium, Unfair) and Emotion Category (Anger, Fear, Sadness, Happiness) as within-subject factors, and Version (Standard, Anger-Infused) as a between-subjects factor. This analysis

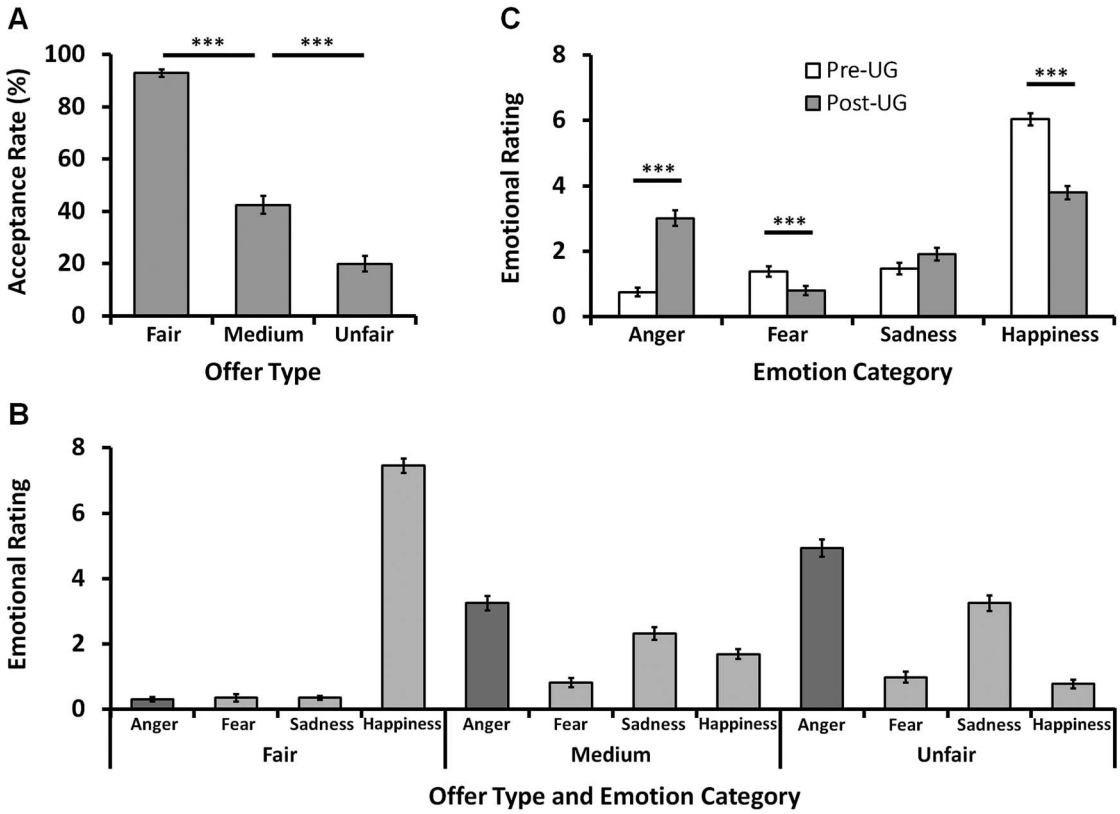

Figure 2. Behavioral and emotional responses in the Ultimatum Game. (**A**) Mean acceptance rates (%) per offer type in the Ultimatum Game (UG), indicating decreased acceptance rates as offers become more unfair. (**B**) Self-reported rating of the emotion categories (Anger, Fear, Sadness and Happiness) in response to the different offer types presented in the UG (Fair, Medium and Unfair), indicating that among fair offers, happiness was rated significantly higher relative to all other emotions (ps < 0.001), while among medium and unfair offers, anger was rated significantly higher relative to all other emotions (ps < 0.001). An increase in anger is apparent as offers become more unfair. (**C**) Change in self-reported rating of state emotion categories from pre- to post-UG, indicating an increase in anger and a decrease in fear (which did not replicate to the second experimental session) and happiness. Since no differences were found between the standard and anger-infused UG versions, data is collapsed across UG versions in all graphs. *** $p < .001$. Error bars signify ± 1 standard error of the mean.

yielded a significant main effect of Offer Type, $F(2, 234) = 12.09$, $p < .001$, $\eta_p^2 = 0.09$. This effect was qualified by a significant Emotion Category × Offer Type interaction, $F(6, 702) = 356.87$, $p < .001$, $\eta_p^2 = 0.75$ (Figure 2B). Follow-up repeated-measures ANOVAs conducted within each offer type revealed significant main effects of Emotion Category, Fs(3, 354) > 31.55, ps < 0.001, η_p^2s > 0.21. Among fair offers, happiness was rated significantly higher relative to all other emotions, $t(118)$s > 27.78, ps < 0.001, ds > 2.55. Among medium and unfair offers, anger was rated significantly higher relative to all other emotions, all $t(118)$s > 4.70, ps < 0.001, ds > 0.43. Unlike our hypothesis, no main or interaction effects of Version emerged, indicating that the emotional evaluation of offers did not differ between UG versions. No other significant effects emerged.

Fairness ratings to the different offer types were also submitted to a repeated-measures ANOVA with Offer Type (Fair, Medium, Unfair) as a within-subjects factor and Version (Standard, Anger-Infused) as a between-subjects factor. We observed a significant main effect of Offer Type, $F(2, 234) = 1004.97$, $p < .001$, $\eta_p^2 = 0.90$. Follow-up tests indicated that perceived fairness decreased as offers became more unfair, $t(118)$s > 11.84, ps < 0.001, ds > 1.09 (for fair relative to medium, and medium relative to unfair). No other significant effects were observed.

Effect of task on state emotions. To examine how state emotions changed due to the UG task, we submitted state emotion ratings provided before and after the task to a repeated-measures ANOVA with Time (Pre-UG, Post-UG) and Emotion Category (Anger, Fear, Sadness, Happiness) as within-subject factors, and Version (Standard, Anger-Infused) as a between-subjects factor. This analysis revealed a significant main effect of Emotion Category $F(3, 351) = 156.16$, $p < .001$, $\eta_p^2 = 0.57$. This effect was qualified by a significant Time × Emotion Category interaction, $F(3, 351) = 87.72$, $p < .001$, $\eta_p^2 = 0.43$ (see Figure 2C). Follow-up tests indicated a significant increase in reported anger following the task, $t(118) = 9.18$, $p < .001$, $d = 0.84$. In addition, a significant decrease in reported fear and happiness was noted, $t(118)$s > 3.42, ps < 0.001, ds > 0.31. We note, however,

that the reduction in fear was not observed in the second session, in either UG versions ($ps > 0.11$), potentially reflecting slightly elevated levels of anxiety prior to task participation. Unlike our hypothesis, no main or interaction effects of Version emerged, indicating that the increase in anger following the task did not differ between UG versions. No other effects were observed.

Convergent Validity

Taylor aggression paradigm (TAP). Participants' chosen noise blast intensity in each TAP round was entered into a repeated-measure ANOVA with Round (1–10) as a within-subject factor, and Version (Standard, Anger-Infused) as a between-subjects factor. Figure 3 presents these data. We observed a significant main effect of Round, $F(9, 684) = 10.02$, $p < .001$, $\eta_p^2 = 0.12$[1], indicating that as the game progressed, participants chose to administer increasing levels of noise blast intensity to their perceived adversaries. In addition, in line with our hypothesis, we noted a trend-level main effect of Version, $F(1, 76) = 3.03$, $p = .086$, $\eta_p^2 = 0.04$, with participants choosing to deliver greater noise blast intensity following the anger-infused relative to the standard UG version. No significant interaction effect was observed.

Three additional measures of aggression were examined. The blast intensity in the first round was used as a measure of unprovoked aggression following the UG because this round is unrelated to subsequent provocations (the opponent's noise blast intensities) in the TAP (e.g., Bushman & Baumeister, 1998; Konijn, Nije Bijvank, & Bushman, 2007). This measure did not differ between the anger-infused (3.40 ± 2.85) and the standard versions (2.71 ± 2.84), $t(76) = 1.07$, $p = .287$, $d = 0.24$. The increase in blast intensity between the first and last round of the TAP and the maximal blast intensity administered during the TAP were used as measures of provoked aggression following the UG. The mean increase in blast intensity did not differ between the anger-infused (2.23 ± 3.48) and the standard versions (1.26 ± 2.85), $t(76) = 1.33$, $p = .187$, $d = 0.31$. However, mean maximal blast intensity was significantly greater in the anger-infused (6.65 ± 3.19) relative to the standard (4.89 ± 3.64) version, $t(76) = 2.27$, $p = .026$, $d = 0.51$[2].

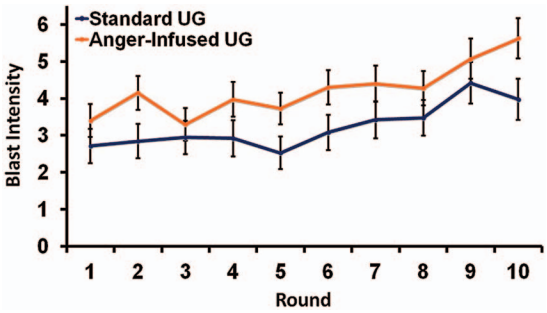

Figure 3. Behavioral responses in the Taylor Aggression Paradigm. The mean noise-blast intensity chosen by participants in each round of the Taylor Aggression Paradigm (TAP) is presented for the standard (blue/black) and anger-infused (orange/gray) versions of the Ultimatum Game (UG), indicating increased noise intensities as the game progressed ($p < .001$). On average there was a trend of higher noise intensities in the TAP following the anger-infused compared to the standard UG version ($p < .10$). Error bars signify ± 1 standard error of the mean. See the online article for the color version of this figure.

Next, we tested changes in state emotions following completion of the TAP. We observed significant main effects of Time, $F(1, 76) = 19.35$, $p < .001$, $\eta_p^2 = 0.20$, and Emotion Category, $F(3, 228) = 18.32$, $p < .001$, $\eta_p^2 = 0.19$. These effects were qualified by a significant Time × Emotion Category interaction, $F(3, 228) = 13.10$, $p < .001$, $\eta_p^2 = 0.15$. A follow-up paired-samples t test indicated a significant increase in reported anger (1.19 ± 2.91), $t(77) = 3.61$, $p < .001$, $d = 0.41$. In addition, reported fear (1.51 ± 2.56, $t(77) = 5.22$, $p < .001$, $d = 0.59$) and sadness (0.99 ± 2.78, $t(77) = 3.14$, $p = .002$, $d = 0.36$) increased following the task, whereas a significant decrease in happiness was noted (1.19 ± 2.71, $t(77) = 3.17$, $p = .002$, $d = 0.36$).

Relationship between trait anger, UG measures, and TAP measures. Table 1 reports on the associations between the primary behavioral measures and emotional reports for the UG, trait anger scores, and TAP measures. These correlations were predominantly significant for the anger-infused UG, and predominantly not significant for the standard UG. Significant version differences were noted for correlations between TAP maximal noise blast and reported anger to unfair offers and increase in reported anger from pre- to post-UG (see Figure 4). To note, observed reductions in fear and happiness in both standard and anger-infused UG versions did not correlate with aversive noise blast intensities ($ps > 0.28$ and $ps > 0.21$, respectively).

Reliability of Primary Behavioral and Emotional Measures of the UG

Finally, we examined the reliability of the main outcome measures of the UG. Table 2 reports on the test–retest correlations for these measures between the first and second sessions. Offer acceptance rates and total gain in the task demonstrated significant correlations in both UG versions, $rs > 0.60$, $ps < 0.001$. Acceptance rates for fair offers correlated significantly higher in the anger-infused relative to the standard UG, $Z = 2.81$, $p = .005$. As for emotion and fairness ratings to unfair offers, significant correlations were observed for all measures in both UG versions, with the exception of happiness rating in the anger-infused UG. Of note, the correlation for fear ratings was significantly higher in the anger-infused relative to the standard UG, $Z = 2.28$, $p = .02$. Changes in self-reported anger, fear, and sadness demonstrated significant test–retest correlations in both versions, $rs > 0.29$, $ps < 0.026$. The magnitude of correlations did not significantly differ between versions for these measures. No significant results were found when testing the interaction effects of Time on UG version on these main outcome measures ($ps > 0.05$).

Discussion

The anger-infused version of the UG was developed to enhance the interpersonal angering nature of unfair offers in the standard

[1] A post-hoc power analysis was conducted using G*Power, version 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). Based on the observed effect size, the analysis resulted in a power of 0.93.

[2] Post-hoc power analysis resulted in a power of 0.60.

Table 1
Convergent Validity of Primary Outcome Measures of the UG

Measures	Standard UG r	Anger-Infused UG r	Difference Z
Trait anger score and:			
Total gain	−.03	−.23^{+}	1.09
Reported anger to unfair offers	.08	.34**	1.46
ΔAnger following UG	.05	.32*	1.50
Maximal TAP noise blast and:			
Total gain	−.16	−.34*	.82
Reported anger to unfair offers	−.07	.45**	2.35*
ΔAnger following UG	−.31^{+}	.33*	2.81**

Note. Correlations with TAP measures were calculated using $n = 38$ and $n = 40$ for the standard and anger-infused UG, respectively. The rest of the correlations were calculated using $n = 59$ and $n = 60$ for the standard and anger-infused UG, respectively. UG = Ultimatum Game; TAP = Taylor Aggression Paradigm. $^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$.

UG. We compared the behavioral and emotional effects of the anger-infused and standard versions of the UG, and examined their psychometric properties as anger-induction paradigms. As expected, the anger-infused UG led to a decrease in acceptance rate with increasing offer unfairness and to an increase in reported anger. The magnitude of these effects was equivalent to that produced by the standard UG. Both versions also demonstrated strong test–retest reliability for the different UG outcome measures. Importantly, however, the outcome measures produced by the anger-infused UG, but not by the standard UG, significantly correlated with trait anger scores, and with subsequent reactive aggression responses as measured by a separate task, indicating better convergent validity. Taken together, these results point to the anger-infused UG as a standardized, reliable, and valid paradigm to induce an interpersonal anger experience and assess its behavioral and emotional expression.

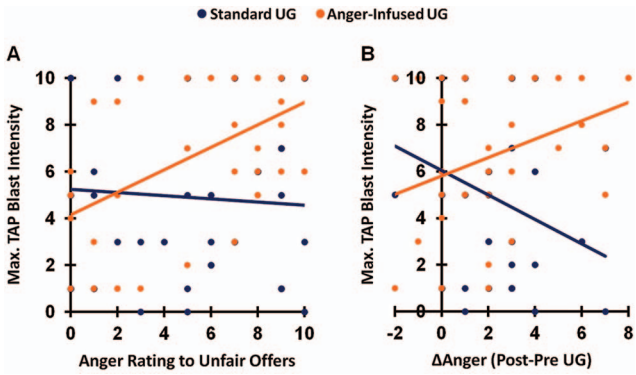

Figure 4. Association between Taylor Aggression Paradigm (TAP) and anger rating in the Ultimatum Game (UG). Scatterplots (and regression lines) illustrate the associations between (**A**) anger rating to unfair offers and (**B**) increase in reported anger (post-UG minus pre-UG) with maximal noise-blast intensity in the TAP, for the standard (blue/black; $r = -.07$ and $r = -.31$, respectively) and anger-infused (orange/gray; $r = .45$ and $r = .33$, respectively) UG versions. The difference in correlation coefficients between the UG versions cases was significant in both cases ($p < .05$ and $p < .01$, respectively). See the online article for the color version of this figure.

Research suggests that emotional experiences occur mostly during or following social interactions (Fischer & Van Kleef, 2010; Gilam & Hendler, 2016; Scherer, Wranik, Sangsue, Tran, & Scherer, 2004), and this is underscored in the case of anger (Baumeister, Stillwell, & Wotman, 1990; Gilam & Hendler, 2015; Scherer et al., 2004). The anger-infused UG aimed to enhance ecological validity by emphasizing the interpersonal nature of offers and thereby evoke anger by both the unfairness of offers as well as by the personal provocations conveyed in the embedded messages, ultimately resulting in improved construct validity. Indeed, this version yielded significant associations between the primary behavioral and emotional anger-related outcomes of the task, trait anger scores, and maximal noise-blast intensity administered during the TAP. These associations were not evident among participants playing the standard UG. However, a significant difference in correlation coefficients between versions emerged only for the correlations of maximal TAP noise blast both with reported anger to unfair offers and with the level of increase in anger between before and after the task. These results indicate that the anger-infused UG, via the coupling between offers and written provocations, is effective in eliciting an experience that relates to the habitual tendency to be angry and associates with subsequent reactive aggression.

Notably, the TAP is considered a paradigm that allows for the assessment of both provoked and unprovoked aggression (e.g., Bushman & Baumeister, 1998; Konijn et al., 2007). From the second round and onward, participants are informed of the noise blast chosen by the opponent and they can retaliate with their own chosen noise blast intensity toward the opponent in the subsequent round. The aggression measured in these rounds represents provoked aggression. In contrast, since there is no TAP-related provocation in the first round, the noise blast intensity toward the opponent in this round is a measure of unprovoked aggression. Previous studies demonstrated greater provoked and unprovoked aggression following manipulations of anger and aggression compared to neutral conditions (e.g., Anderson & Bushman, 2001; Gabbiadini, Riva, Andrighetto, Volpato, & Bushman, 2014; Konijn et al., 2007). Here, provoked aggression (maximal noise blast intensity) was significantly greater following the anger-infused relative to the standard UG, but unprovoked aggression

Table 2
Test–Retest Reliability of the Main Outcome Measures of the UG

	Standard UG	Anger-Infused UG	Difference
Measures	r	r	Z
UG Behavior			
Acceptance: Fair (%)	.60***	.84***	2.81**
Acceptance: Medium (%)	.76***	.77***	.13
Acceptance: Unfair (%)	.77***	.67***	1.11
Total Gain	.82***	.81***	.16
Rating for unfair offers			
Anger	.55***	.63***	.65
Fear	.58***	.80***	2.28*
Sadness	.41**	.48***	.46
Happiness	.34**	.08	1.46
Fairness	.58***	.75***	1.65+
Change in emotion following UG			
ΔAnger	.49***	.48***	.07
ΔFear	.29*	.41**	.73
ΔSadness	.45***	.45***	.02
ΔHappiness	.17	.17	.01

Note. Values in the table reflect Pearson correlation coefficients (r) for each measure, between the first and second time that the task was completed and calculated separately for each UG version, and differences between the magnitude of these correlations (Z, Fisher's r-to-Z). Δ reflects change in reported emotion ratings (post-UG rating minus pre-UG rating). UG = Ultimatum Game.
$^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

(first round noise blast intensity) did not differ. Nevertheless, unlike previous studies that used a neutral control condition, the standard UG induces anger and is not neutral per se. Moreover, the partial loss of TAP data may have reduced our ability to detect significant effects. Finding differences in provoked aggression between UG versions despite these constraints supports the validity of the anger-infused version in inducing anger. Future studies should further examine the relation between provoked and unprovoked aggression and measures of the anger-infused UG by administering the TAP before the anger-infused UG.

The effects of the UG on participants' emotional state indicated a significant increase in anger. Complementing this effect, we also noted a decrease in happiness, replicating previous findings as to the inverse relationship between anger and happiness (e.g., Chapman et al., 2009; Cohen, Nisbett, Bowdle, & Schwarz, 1996; Harmon-Jones, Sigelman, Bohlig, & Harmon-Jones, 2003; Riepl et al., 2016; Schwartz & Weinberger, 1980). The two additional negative emotion categories assessed—fear and sadness—did not show a pre- to post- task increase, refuting the possibility that the UG induced a general negative mood effect. Moreover, unlike change in reported anger, changes in fear and happiness ratings did not correlate with aggressive behavior in the TAP. Together, these results emphasize the suitability of the anger-infused UG as an anger-inducing paradigm.

A potential account for the enhanced validity of the anger-infused version in inducing anger is that the malicious intent associated with the angering messages facilitated the attribution of a sense of blame to the proposer, thereby evoking a more authentic experience of anger. The importance of blame for the arousal of anger has been subject to debate. While some argue that blame is an unnecessary consequence of anger and thus has only a quantitative effect on anger (e.g., Berkowitz & Harmon-Jones, 2004), others claim that attribution of agency in the form of blame is required to generate a qualitatively different experience of anger as compared to, for example, frustration (e.g., Clore & Centerbar, 2004). That no differences emerged in the intensity of anger between the two versions seems to support the former. Nevertheless, it was previously demonstrated that the UG engages brain regions associated with attribution of agency (Rilling, Sanfey, Aronson, Nystrom, & Cohen, 2004), and this attributional process might be further enhanced by the inclusion of interpersonal provocations. Alternatively, it is possible that the requisite of attributing malicious intent in order to evoke anger is in fact subject to individual differences (Kuppens et al., 2007). Future studies specifically assessing blameworthiness and attribution of agency may aid in elucidating the specific nature of the effects presented here.

The anger-infused UG follows previous use of interpersonal interactions and messages to induce anger. For example, in some cases, a confederate bumps into participants and then provokes them by insulting ("Asshole!"; e.g., Cohen et al., 1996) or threatening them ("Hey, watch it!"; e.g., Ijzerman, van Dijk, & Gallucci, 2007). Other studies incorporated accusations of intentional noncompliance toward the participants, usually accompanied by cold and annoyed tone of voice (e.g., Siegman, Anderson, Herbst, Boyle, & Wilkinson, 1992; Stemmler, 1997), or insulting criticism of an essay or a speech by the participant (e.g., Harmon-Jones & Sigelman, 2001; Memedovic, Grisham, Denson, & Moulds, 2010; Moons & Mackie, 2007). Nevertheless, in these cases participants were passive and subject to insults or criticism without being able to react, especially if incorporated in neuroimaging studies (Denson, Pedersen, Ronquillo, & Nandy, 2009; Harmon-Jones, Vaughn-Scott, Mohr, Sigelman, & Harmon-Jones, 2004). Importantly, in all these variations, an inherent behavioral measure of an anger response was absent from the task. The UG, however, provides a promising platform for studying individual differences in anger experience and expression since unfair offers are continuously associated with the elicitation of angry feelings, which subsequently contribute to the aggressive rejection of such offers. Moreover, it provides an

objective behavioral measure (i.e., offer accepted/rejected or total gain), it incorporates an inherent interpersonal context in the anger experience, and its standardized methodology enables it to be easily adaptable to various neuroimaging modalities. Indeed, for more than three decades, the UG has been trailblazing in the fields of economics, psychology, anthropology, neuroscience, and many more, establishing itself as a canonical social decision-making paradigm (Güth & Kocher, 2013; van Damme et al., 2014). Nonetheless, the anger literature has largely overlooked the potential usage of the UG as an anger-induction paradigm (e.g., Berkowitz & Harmon-Jones, 2004; Lench, Flores, & Bench, 2011; Lobbestael, Arntz, & Wiers, 2008). There have been previous behavioral studies using negotiations (e.g., Van Kleef, De Dreu, & Manstead, 2004) and in fact implementing an ultimatum bargaining context (e.g., van Dijk, van Kleef, Steinel, & van Beest, 2008), while incorporating interpersonal messages between negotiating sides to convey anger and result in the induction of anger. However the systematic evaluation of these paradigms as anger-induction paradigms, or of the UG itself for that matter, has remained until now unaddressed. Notably, most previous anger-induction paradigms have not been assessed in clinical contexts, while the UG has already shown promise in this domain (e.g., Gilam et al., 2017; White et al., 2015). The anger-infused UG induces a reliable naturalistic experience of anger, and its behavioral and emotional measures converge with reactive aggression and trait anger. Therefore, while additional validation studies are in place, the current study provides the initial necessary psychometric information for the utilization of the anger-infused UG in future empirical investigations of anger. An additional important application of this instrument is to examine the downstream effects of anger on various domains including for example judgment and decision-making (e.g., Lerner & Tiedens, 2006), attitudes (e.g., Huntsinger, 2013), stereotypical behavior (e.g., DeSteno, Dasgupta, Bartlett, & Cajdric, 2004) and morality (e.g., Salerno & Peter-Hagene, 2013).

Limitations

Several limitations and future directions should be noted. First, due to the somatovisceral activation of anger (Stemmler, 2010), the inclusion of a physiological measure could have further contributed to the validity of the task as an anger inducing paradigm. Although previous studies demonstrated the physiological arousal elicited by standard unfair offers (e.g., Dunn, Evans, Makarova, White, & Clark, 2012; Hewig et al., 2011), future studies may employ such assessment, as well as related methodologies, to further validate and explore the physiological underpinnings of the anger-infused UG. Future studies should similarly add a deception assessment to ascertain the believability of the manipulation and of the interpersonal messages. In addition, behavioral and subsequently emotional responses in the task might have been biased by incentivizing participants to earn money in order to increase their chances of obtaining an additional monetary reward at the end of data collection. While others employed a similar incentive (Campanha, Minati, Fregni, & Boggio, 2011; Gilam et al., 2015), the influence that different financial incentives have on UG behavior is inconclusive (Camerer, Hogarth, Budescu, & Eckel, 1999; Gillis & Hettler, 2007). Nonetheless, the fact that participants decided to reject a substantial amount of offers, leading to potential monetary loss, further corroborated the important role of emotions in driving decisions in the task. Future studies may examine whether utilizing an alternative financial incentive such as a fixed percentage of total earning as payment (e.g., Harlé & Sanfey, 2007), or a responder's decision on one random offer as payment (e.g., Dunn et al., 2012), differently impacts the primary behavioral and emotional measures. Finally, the use of written interpersonal messages requires participants have adequate levels of reading comprehension. This could limit the applicability of the paradigm in certain clinical and developmental settings. One potential path to overcome this obstacle is by changing the format in which the messages are communicated to an auditory stimulus accompanying the offers. This may in fact further increase ecological validity by incorporating tone of voice and prosody to the interpersonal communication.

Conclusion

Excessive anger can lead to detrimental outcomes to the individual as well as to his or her social environment, and is a key cross-diagnostic feature of numerous psychiatric conditions. Experimentally inducing anger in a reliable and valid manner is central to the study of this phenomenon. The current findings indicate the anger-infused UG is a psychometrically sound paradigm to induce and assess a genuine, interpersonal anger experience and its emotional and behavioral manifestation. The standardized administration of the anger-infused UG makes it particularly useful for basic and clinical research settings, underscoring its applicability for the empirical investigation of anger.

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