



Published in final edited form as:

Emotion. 2010 December ; 10(6): 815–821. doi:10.1037/a0020069.

The influence of emotion regulation on social interactive decision-making

Mascha van 't Wout^{1,2}, Luke J. Chang¹, and Alan G. Sanfey¹

¹Neural Decision Sciences Laboratory, Department of Psychology. University of Arizona, Tucson AZ, USA.

²Department of Cognitive, Linguistic and Psychological Sciences. Brown University, Providence RI, USA.

Abstract

Although adequate emotion regulation is considered to be essential in every day life, it is especially important in social interactions. However, the question as to what extent two different regulation strategies are effective in changing decision-making in a consequential socially interactive context remains unanswered. We investigated the effect of expressive suppression and emotional reappraisal on strategic decision-making in a social interactive task, i.e. the Ultimatum Game. As hypothesized, participants in the emotional reappraisal condition accepted unfair offers more often than participants in the suppression and no-regulation condition. Additionally, the effect of emotional reappraisal influenced the amount of money participants proposed during a second interaction with partners that had treated them unfairly in a previous interaction. These results support and extend previous findings that emotional reappraisal as compared to expressive suppression, is a powerful regulation strategy that influences and changes how we interact with others even in the face of inequity.

Keywords

emotion regulation; decision-making; reappraisal; ultimatum game; social interactions

Introduction

Emotion regulation is a vital component of everyday life and inappropriate emotion regulation has been associated with a variety of psychiatric disorders and aggression (Davidson, Putnam, & Larson, 2000; Gross & Munoz, 1995). Broadly speaking, emotion regulation refers to a diverse set of processes by which “individuals influence which emotions they have, when they have them, and how they experience and express these emotions” (cf. Gross, 1999). Although there are many different approaches people can use to regulate their emotions, two well-studied strategies are expressive suppression and emotional reappraisal. These two processes appear to differ in their effect on emotional experience and the associated psychophysiological processes, such as heart rate, skin

Corresponding author: M. van 't Wout, Brown University, Thayer Str. 190, Box 1978, Providence, RI 02912, USA, Tel: +1 401 863 6487; Fax: +1 401 863 2255, maschavantwout@gmail.com.

Publisher's Disclaimer: The following manuscript is the final accepted manuscript. It has not been subjected to the final copyediting, fact-checking, and proofreading required for formal publication. It is not the definitive, publisher-authenticated version. The American Psychological Association and its Council of Editors disclaim any responsibility or liabilities for errors or omissions of this manuscript version, any version derived from this manuscript by NIH, or other third parties. The published version is available at www.apa.org/pubs/journals/emo.

conductance responses and neural activity. Whereas reappraisal is often capable of lowering emotional experience, reducing or altering psychophysiological activity, and improving social functioning (Goldin, McRae, Ramel, & Gross, 2008; Gross, 2002; Gross & John, 2003; Ochsner, Bunge, Gross, & Gabrieli, 2002), expressive suppression seems much less effective in these respects and might even have negative social consequences (Butler et al., 2003; Gross, 2002; Gross & John, 2003; Harris, 2001). Nevertheless regulatory effects of suppression on neural responses have been observed, albeit later in time than was observed for reappraisal and which may reflect increased effort to continue inhibition or cognitive control when people are asked to suppress negative emotions (Goldin, McRae, Ramel, & Gross, 2008).

The effectiveness of regulation has been tested in various circumstances including the ability to increase and decrease positive emotions, the associated physiology and neural responses as induced by film clips and expectations of reward (Delgado, Gillis, & Phelps, 2008; Giuliani, McRae, & Gross, 2008). However, the majority of studies to date are restricted to measuring the ability to regulate negative feelings induced by either the viewing of negatively-valenced images or by the anticipation of negative events, such as electric shocks (Delgado, Nearing, LeDoux, & Phelps, 2008; Ochsner et al., 2004; Wager, Davidson, Hughes, Lindquist, & Ochsner, 2008). Nevertheless, the effectiveness of emotion regulation strategies is dependent to some degree on the specific type of stimulus and the emotion to be regulated (see Ochsner & Gross, 2008 for a review).

In everyday life we are typically confronted with a variety of emotions directly induced by interpersonal interactions, and emotion regulation seems thus particularly critical in social behavior. Therefore, investigating whether emotion regulation strategies can have an effect on actual decisions made in social contexts is important, as it extends emotion regulation research beyond visceral responses to emotion-laden pictures into potentially more complex social interactions. A recent study examining the effects of regulation on decision-making demonstrated that after reappraisal, participants showed reductions in loss aversion and arousal responses to losses (Sokol-Hessner, Hsu, Curley, Delgado, Camerer, & Phelps, 2009). Although these results are important for decision-making, they do not address the ability to regulate emotions elicited in a social interaction, which may be of a qualitatively different nature than those experienced while watching disturbing images or during simple gambles. Thus, it remains an open question whether these strategies can be effective in regulating such emotions and influencing decision-making behavior in a more complex social interactive setting.

A useful approach to measure this is to adopt a set of tasks commonly used in experimental economics. These tasks allow assessment of how social factors such as reciprocity, equity, and bargaining can affect decision-making, and particularly how emotional responses associated with these factors can exert strong influences on decisions. One commonly-used task in this field is the Ultimatum Game (Guth, Schmittberger, & Schwarze, 1982) in which two players must agree on the division of a sum of money provided by the experimenter. Player 1, the Proposer, first makes a proposal as to how the money should be split. Then, Player 2, the Responder, has the opportunity to either accept or reject this proposal. If it is accepted, the money is divided as proposed, but if the responder rejects the offer, neither player receives any money. In either event, the game is over, that is, there are no subsequent rounds to arrive at a new arrangement. Contrary to the predictions of classical economic theory, low offers are routinely rejected in this task, often as much as half of the time (Bolton & Zwick, 1995; Guth et al., 1982; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003; Thaler, 1988; Van 't Wout, Kahn, Sanfey, & Aleman, 2006).

Research has demonstrated that the rejection of unfair offers in the Ultimatum Game is related to feelings of anger (Pillutla & Murnighan, 1996), and in turn to neural activation in areas associated with negative emotional states, e.g. insula (Sanfey et al., 2003), as well as psychophysiological responses indicating emotional arousal (Van 't Wout et al., 2006). Moreover, a recent study showed that when feelings of sadness are induced via an unrelated manipulation, people will reject a greater number of unfair offers as compared to the elicitation of a neutral or happy mood (Harle & Sanfey, 2007). Taken together, there is a growing body of evidence that decisions made in the Ultimatum Game seem to be, at least partially, based on emotional responses. The Ultimatum Game is therefore a useful avenue for investigating the influence of emotion regulation strategies in a socially interactive setting.

Thus, the overall goal of this study was to investigate the influence of reappraisal and expressive suppression on emotions elicited in social interactions in which participants make consequential economic decisions. Based on previous research showing reappraisal as more effective than suppression, as summarized above, we hypothesized that negative feelings induced by receiving unfair offers in the Ultimatum Game would be lessened by the use of reappraisal as an emotional regulation technique. This would result in higher acceptance rates of unfair offers when asked to reappraise as compared to when suppression was used, or to a baseline condition where no regulation was performed.

In addition, we were also interested in exploring carry-over effects of these regulation strategies. The Ultimatum Game allows investigation of so-called 'one-shot' interactions, but obviously in everyday life repeated interactions with the same person often occur. It would therefore be particularly interesting to examine whether emotion regulation has an extended influence, that is, one beyond the 'regulated' interaction. For example, does regulating one's emotion to an unfair proposal have extended effects on the way we deal with that person in the future? To answer this, participants were paired with their partners for a second time, but now were placed in the role of Proposer, allowing for an examination of whether emotion regulation would lead to less punishment of partners, that is, by proposing higher offers to them.

Methods

Participants

50 Undergraduate students (38 female, 12 male) from the University of Arizona participated in the study, with 26 participants randomly assigned to the suppression condition and 24 participants to the reappraisal condition. The mean age of the participants was 18.98 years (SD 1.63), and there was no difference between the groups with respect to either age ($t(48) = -0.59, p = .55$) or gender (Mann-Whitney $U = -0.81, p = .42$).

The local ethics committee approved the study and all participants provided written informed consent after the procedures had been fully explained, in accordance with the Declaration of Helsinki.

Ultimatum Game—After providing informed consent, participants were first instructed as to the nature and rules of the Ultimatum Game. Participants were told that on each round they would play this game in both roles, firstly as responder and then as proposer with the same partner. Following this they would repeat the games with a new partner, for a total of 24 rounds. Participants were not informed of the total number of rounds in advance. The task instructions emphasized that the different partners in the game would play the game independently of each other, and participants were led to believe the games would be played for real with the set of partners they saw. To encourage participants to make real decisions it

was emphasized that they would be paid 5% of the total amount of money that was earned in the game in addition to course credit.

Participants played the game using a computerized version of the task. Each round involved firstly playing as a responder and then as a proposer with that same partner, with each trial dividing \$10. As responder, the set of offers received by each participant was pre-assigned. This set of 24 offers comprised of 6 fair offers (\$5 to each player) and 18 unfair offers, defined as offering the participant less than half of the money. The unfair set was composed of 6 offers of \$3, 6 offers of \$2 and 6 offers of \$1. We did not include \$4 offers as these are generally perceived as fair and thus frequently accepted. To maximize the number of unfair offers we opted to not use \$4 offers. Half of the offers were made by a male partner, and half by a female partner. The order of partners and the pictures associated with each offer was randomized. When playing as proposer, participants were free to offer any dollar amount between \$0 and \$10. After the offer was made participants saw the outcome, either an acceptance or a rejection (see Figure 1 for an example of a full trial). All fair offers were accepted, with 80% of \$3 and \$4, and 40% of \$1 and \$2 offers accepted, selected randomly in accordance with these probabilities.

Each participant played two of these 24-round Ultimatum Games, once in which they were asked to regulate their emotions (regulation condition, either using the technique of suppression or reappraisal), and once in which they played without any regulation instructions (baseline condition). The administration order of the two sets was counterbalanced across participants.

Emotion regulation—Before beginning the game in the regulation condition, participants were instructed that they would have to regulate their emotions associated with the offers they would see, with one group instructed to use suppression and one instructed to use reappraisal. To explain how these regulation techniques should work, we followed previously published instructions from Gross (1998) by adapting the instructions. In the Gross (1998) study “*reappraisal was defined as interpreting potentially emotion-relevant stimuli in unemotional terms, whereas suppression was defined as inhibiting emotion-expressive behavior while emotionally aroused*” (c.f. Gross, 1998). In addition to expressive suppression, we asked participants in the suppression condition to suppress emotional feelings.

The key instructions in the suppression condition are summarized as follows: “It is very important to us that you try your best not to show any signs of emotional feelings and suppress any emotional feelings as you watch the offers. To do this, we would like for you to not let your feelings show and influence you as you watch the offers”. When participants were asked to reappraise their emotions they saw the following instructions: “It is very important to us that you try your best to adopt a neutral attitude as you watch the offers. To do this, we would like for you to view the offers with detached interest or try to come up with possible reasons why someone might give you a certain offer.”

Before beginning the Ultimatum Game task (but after the practice trials), we verified that participants understood the respective emotion regulation instructions by asking each to verbalize what they would do when confronted with a very unfair offer. Two of the 50 participants (one in each regulation strategy) expressed difficulties in being able to regulate their emotions as instructed, and were therefore excluded from further analyses. When participants played the baseline condition (either before or after the particular emotion regulation condition), we presented the game without any extra explanation other than highlighting that they could play the game as normal.

At the end of the experiment, participants were asked to rate how angry (annoyed/frustrated) they felt when they received unfair offers in both the regulation and baseline conditions on a 5-point scale from -2 (not at all), 0 (neutral), +2 (very) scale. Therefore the emotion ratings were intended to measure overall negative emotions experienced when receiving unfair offers.

Results

Ultimatum Game responder behavior

Across all conditions fair offers (\$5) were always accepted, with the exception of one participant rejecting a fair offer on a single occasion, and, as is generally seen in the Ultimatum Game, acceptance rates decreased as the offers became progressively more unfair (Camerer, 2003): \$5-\$5: $M=99.1\%$ ($SD=0.05$); \$7-\$3: $M=59.9\%$ ($SD=0.37$); \$8-\$2: $M=33.5\%$ ($SD=0.36$); \$9-\$1: $M=24.5\%$ ($SD=0.33$).

Reappraisal—To examine the effect of reappraisal on acceptance rates, we conducted a 2 (emotion regulation condition: reappraisal vs. baseline) \times 4 (offer: \$5, \$3, \$2, \$1) within-subject ANOVA. Results showed a main effect of emotion regulation, $F(1,22)=14.66$, $p < .001$, a main effect of offer, $F(3,20)=31.13$, $p < .0001$, and an interaction between emotion regulation and offer, Greenhouse-Geisser $F(3,20)=3.13$, $p < .05$. Post-hoc paired sample t-tests demonstrated increased acceptance rates after reappraisal as compared to the baseline condition, for the most unfair offers in particular (\$1: $t(22)=-2.80$, $p < .05$; \$2: $t(22)=-3.51$, $p < .01$; \$3: $t(22)=-1.89$, $p = .07$). See Figure 2.

Suppression—To investigate emotional suppression, we conducted a similar 2 (condition: suppression vs. baseline) \times 4 (offer: \$5, \$3, \$2, \$1) within-subject ANOVA. This analysis demonstrated, as expected, a main effect of offer $F(3,22)=49.49$, $p < .0001$, but no significant main effect of emotion condition $F(1,24)=0.04$, $p = .85$, and no significant interaction, Greenhouse-Geisser $F(3,22)=0.25$, $p = .79$. Indeed, post-hoc paired sample t-tests did not show a difference between suppression and baseline on any of the unfair offers: (\$1: $t(24)=0.55$, $p = .59$; \$2: $t(24)=-0.41$, $p = .68$; \$3: $t(24)=0.35$, $p = .73$). See Figure 2.

Reappraisal vs. Suppression—To test whether there was a difference in decision behavior between the two regulation strategies of suppression and reappraisal, we compared Ultimatum Game behavior of participants in these two conditions. A 4 (offer: \$5, \$3, \$2, \$1) \times 2 (emotion regulation type: suppression vs. reappraisal) ANOVA with offer as a within subject variable and emotion regulation type as a between subject variable revealed a main effect of offer (Greenhouse-Geisser $F(3,44)=67.42$, $p < .0001$), a main effect of regulation type ($F(1,46)=7.09$, $p < .01$) and a significant interaction between offer and regulation type (Greenhouse-Geisser $F(3,44)=3.59$, $p < .05$). Post-hoc t-tests showed that, for all unfair offers, acceptance rates in the reappraisal condition were higher than in the suppression condition (\$1: $t(46)=-2.13$, $p < .05$; \$2: $t(46)=-2.63$, $p < .05$; \$3: $t(46)=-2.64$, $p < .05$). See Figure 2.

Also when looking at the actual payoffs, we observed a significant effect of emotion regulation type on the amount of money earned (one-way ANOVA $F(1,46)=8.10$, $p < .01$) in which participant earned more money in the reappraisal condition ($M=\$53.57$, $SD=12.45$) as compared to the suppression condition ($M=\$42.62$, $SD=13.82$).

Order effects—Across participants, the order in which they played the baseline and regulation conditions was counterbalanced, therefore half of our participants played the baseline rounds after playing the regulation rounds. To ensure that both baseline

performance and regulation performance was not affected by task administration order (regulation first or baseline first), we separately examined baseline and regulation performance in both the reappraisal and suppression groups with regulation order as a covariate. Results showed no significant interaction between baseline acceptance rates and order ($F(3,43)=0.34, p=.79$) and regulation acceptance rates and order ($F(3,43)=2.14, p=.10$). This demonstrates that baseline performance and regulation performance was not affected by the ordering of the conditions, that is, whether they played the emotion regulation or baseline condition first.

Ultimatum Game proposer behavior

Since we were also interested in investigating whether emotion regulation would influence a second interaction with the same person, we examined proposer behavior of the participants during the subsequent Ultimatum Game interaction with each partner. Using a mixed linear model, we tested whether the participant's offer when playing as Proposer was related to the type of emotion regulation employed (suppression vs. reappraisal, and their baselines). However, we further expected that the amount of money that was offered in the first interaction (e.g. \$5, \$3, \$2 or \$1) as well as the participant's subsequent decision to accept or reject the proposed offer would influence the amount of money being offered in the second encounter. Specifically, we predicted that participants would match their return offer to the initial offer received. For example, after being initially offered \$2 we expected participants to propose a similar amount in their subsequent interaction (i.e., \$2 or \$3). We further hypothesized that this effect would be influenced by the participants' decisions. That is participants should be more likely to propose a similar offer to what they initially received if they accepted the offer, and would likely make a higher offer to proposals they rejected to illustrate what they believed was more reasonable. Therefore, we added the initial offer and the participant's decision (i.e., whether the offer was accepted or rejected) as predictors to the mixed linear model. The following three variables were entered into the model, 1) regulation condition: suppression, reappraisal or baseline, 2) initial offer proposed: \$5, \$3, \$2, \$1, and 3) decision of participant: reject or accepted proposed offer. Subjects were modeled as random effects.

Analyses revealed that there was a main effect of emotion regulation ($F(2,2209.66)=18.68, p<.0001$), with higher proposer offers made after participants reappraised their emotions. This conclusion is supported by examining the frequency of so-called "hyperfair" offers, that is, offers of more than half of the \$10 pot on a given trial. These offers occurred 52 times (involving 9 participants) in the reappraisal condition, but occurred significantly less often in both the suppression (11 trials, 4 participants) and the baseline (26 trials, 10 participants) conditions ($X^2=9.77, df=4, p<.05$).

As expected, the magnitude of the initial offer proposed to the participant had a significant influence on the amount offered to the partner in the subsequent trial ($F(3, 2195.49)=8.79, p<.001$), demonstrating that partners who made higher offers received higher offers back in return. Further, the decision to accept or reject the offer by the participant in the initial interaction had a significant effect on the amount of money that was offered in the subsequent interaction, namely that participants proposed higher offers after they rejected the initial offer compared to when they accepted the initial offer ($F(1,2220.58)=5.36, p=.02$). See Figure 3 for a graphical depiction of these results. However, the effects of the initial offer amount and the participant's decision were only significant in the suppression group ($F(3,1144.08)=131.84, p<.0001$ and $F(1,1161.52)=120.86, p<.0001$ respectively), but not in the reappraisal group ($F(3,1070.42)=1.16, p=.32$ and $F(1,1085.48)=0.32, p=.57$ respectively). This shows that after reappraisal participant's return offers were *not* influenced by the amount of money offered to them in the initial interaction and whether they decided to accept or reject the initial offer.

Given the probabilities associated with our predetermined payoff structure, a \$3 offer had the highest expected value (5.6) and a \$10 or \$0 had the lowest expected value (0). To test whether participants adapted their behavior over time to accommodate this strategy we rank ordered all possible offers according to their expected value and tested the effect of trial order for the different regulation conditions. None of these effects were significant (no regulation: $F(23,1057.02)=0.81$, $p=.72$; reappraisal: $F(23,506)=0.78$, $p=0.76$; suppression: $F(23,552)=0.88$, $p=0.63$).

Emotion ratings and debriefing

Most participants reported that they were somewhat negatively (angry, annoyed, frustrated) affected when they received unfair offers, but there were no differences in self-reported negative affect between the regulation groups on how they angry they felt after receiving an unfair offer at baseline (Mann-Whitney = -0.79 , $p=.43$) or after regulation (Mann-Whitney = -1.31 , $p=.19$).

However, during debriefing 9 of the 23 participants in the reappraisal condition mentioned feeling less emotional or frustrated as compared to the baseline condition, and 10 also reported themselves as being more altruistic in the reappraisal condition as compared to baseline. None of the participants in the suppression condition reported either of these effects. Rather, in the suppression condition 11 participants out of 25 reported no difference between suppression and baseline, 5 participants reported a difference but did not specify the direction, and 2 participants reported that they felt more emotional during suppression.

Discussion

In this study we examined whether two different regulation strategies, emotional reappraisal and suppression, could affect behavior in an interactive social decision context. Our data demonstrate that when people were asked to reappraise their emotions while being confronted with unfair offers proposed by others, they were more likely to accept these offers as compared to when the same participant decided about offers without using regulation strategies. This effect was particularly strong in the two most unfair offers (\$1 and \$2 offered out of \$10), although we also observed a trend for \$3 offer. We did not observe a significant difference in the acceptance rates of unfair offers when participants were asked to suppress their emotions, as compared to the respective baseline condition. This suggests that reappraisal uniquely had an influence on decision-making behavior in the Ultimatum Game.

This conclusion was further supported by our between-group comparison, which showed that the use of reappraisal led to higher acceptance rates for all unfair offers and the accumulation of money in the game as compared to when suppression was used as an emotion regulation technique. This result was not due to differences in baseline performance, which were very similar across conditions, and was also not affected by whether the emotion regulation or baseline condition was played first. Based on these findings, we conclude that regulation, and reappraisal specifically, can effectively influence decision-making in a social interactive context where choices have direct economic consequences. These results are consistent with previous emotion regulation studies that demonstrate reappraisal is more effective in the down-regulation of negative emotions than suppression (Gross, 2002; Gross & John, 2003). However, they extend previous studies by demonstrating that reappraisal can significantly modify interpersonal decision-making behavior in a more complex social setting.

Given that we often interact repeatedly with the same person, we also examined whether regulation had an effect on interpersonal behavior in a subsequent encounter with a partner.

Our results showed that, as compared to both suppression and baseline, reappraisal resulted in the proposal of higher subsequent offers, even though these partners had treated the participants unfairly in the past. This is a notable finding and shows that reappraisal does not only influence social interactive decision-making behavior at the moment that the interaction is regulated, but that this influence extends to a subsequent interaction on which regulation was not focused. Further the amount of money that was proposed in the second interaction was related to the amount of money that was initially offered, which could be an indication of a social norm or participants retaliating (“you are (un)fair, I am (un)fair”). Moreover, after an initial offer was rejected, participants proposed a higher return offer. This can be explained by participants realizing that after rejecting certain offers they cannot give a similar (or lower) offer as this will for sure be rejected. Another explanation, based on Xiao and Houser’s (2005) who proposed that the rejection of unfair offers is a way of expression negative feelings associated with receiving these offers, is that after participants have expressed their dislike of the unfair offer they use the second encounter as an opportunity to show their partners what they think a reasonable offer is. Interestingly these findings were only significant for participants in the suppression group and not for those using reappraisal, suggesting that after reappraisal participants did not allow negative events of a previous interaction (receiving and disapproval of an unfair offer) interfere with behavior in a subsequent interaction.

A possible explanation as to why reappraisal influences decision-making in the Ultimatum Game is because reappraisal is an antecedent focused strategy and capable of manipulating information before it elicits an emotional reaction thereby substantially reducing negative emotional experiences. Suppression on the other hand is a response-focused strategy and can only influence an already existing emotional reaction (Gross, 1998). Entering a social interaction while being able to see someone else’s perspective (in need of money, not personal, etc) or the bigger picture (here: some money is better than no money) might prevent the development of a negative emotion reaction. Successful reappraisal of negative feelings, such as anger and frustration associated with being treated unfairly (Camerer, 2003; Fehr & Gächter, 2002; Pillutla & Murnighan, 1996) can thus reduce the need for punishment, i.e. rejection of those offers. This could also explain why the effect of reappraisal is more pronounced for the two most unfair offers (\$1 and \$2), as it has been demonstrated that these offers in particular are associated with the strongest negative emotional feelings and associated neural responses (Koenigs & Tranel, 2007; Sanfey et al., 2003; Van 't Wout et al., 2006).

A different explanation for why reappraisal has an effect on Ultimatum Game behavior is that during reappraisal participants might focus on the positive effects of accepting offers, i.e. gaining money (something is better than nothing), or social interaction, i.e. helping someone who might be in need of money, and thereby changing their perspective in the game. We purposely did not measure subjective emotion directly after the presentation of unfair offers in each condition as is often done in emotion regulation studies, because we believe this would have greatly interrupted game play behavior. Therefore we cannot draw strong conclusions about whether a shift in focus towards positive effects of accepting offers or a reduction in negative feelings in response to unfair offers after reappraisal causes participants to accept more unfair offers. Future research is necessary to understand the processes underlying the effect of reappraisal in social interactions. In particular, whether the behavioral changes in the game are mediated by successful perspective taking or detached interest in the offers. Additionally, future studies could use psychophysiological measures, such as skin conductance responses as these appear to be a reliable indication of emotional arousal when confronted with unfair offers (Van 't Wout et al., 2006).

Although our findings strongly support the notion that reappraisal can have a powerful effect on social interactive behavior, one possible alternative hypothesis is that our results are due to cognitive and/or experimental demand effects. Reappraisal compared to no regulation might be more cognitively demanding and could have distracted participants away from the game resulting in emotions being experienced to a lesser degree and lower rejection rates accordingly. Experimental demand effects on the other hand refer to the tendency of people to follow instructions which could have had an influence on reduced rejection rates after reappraisal. Importantly however, we did not observe a difference in decisions made in the suppression condition from baseline, in which people also received specific instructions (cognitive demand) that specified to not let feelings influence them (experimental demand). In addition, we observed that after reappraisal participants proposed more 'hyper-fair' offers (more than half of the total amount) to their partners as compared to participants in the suppression condition. If cognitive or experimental demand effects were the main reasons for the shift in decisions made in the game, we would not expect these hyper-fair offers as a result. Instead, the hyper-fair offers might reflect the participant's self-report of being more altruistic (Kahneman, Knetsch, & Thaler, 1986). It is also worth noting that we still observed significant results despite the fact that our participants underwent the bare minimum of training on both of these regulation techniques prior to the experiment.

Studies investigating the neural basis of emotion regulation have demonstrated that the reappraisal of emotions is associated with a down-regulation of brain areas associated with emotional processing, such as the amygdala, by an increase in activation of the prefrontal cortex (Ochsner et al., 2002). Sanfey et al. (2003) proposed a relationship between anterior insula and dorsolateral prefrontal cortex in response to unfair offers in the Ultimatum Game, such that greater activation of the anterior insula, a brain area associated with the processing of aversive emotions such as anger and disgust (Phillips, Young, Senior, & al., 1997), was associated with the rejection of unfair offers, with the opposite pattern, i.e. greater dorsolateral prefrontal cortex, associated with the acceptance of unfair offers. Thus, one potential hypothesis is that adequate emotion regulation in the Ultimatum Game could involve a down regulation of the insula relative to dorsolateral prefrontal cortex. This could also be relevant for (social) aggression which is associated with dysfunction in the neural circuitry of emotion regulation (Davidson et al., 2000), with spouse abusers showing increased amygdala, insula and hippocampus activation and reduced middle frontal gyrus and anterior cingulate activation in response to aggressive stimuli (Lee, Chan, & Raine, 2008).

In sum, we investigated the effect of two well-known regulation strategies, reappraisal and suppression, on socially interactive decision-making after being treated unfairly by another person. This question is important, as it extends the regulation literature beyond visceral responses to emotion-laden pictures, to potentially more complex social interactions. Our results show that reappraisal specifically influences decision-making when treated unfairly by others. In addition, the effect of regulation extends beyond a single encounter, and that reappraisal can even influence a future interaction. Therefore, reappraisal appears to be a robust and effective technique to alter social interactive decision-making. Not only do these findings provide more insight in the effect and influence of regulation strategies on personal interactions, it also sheds more light on the unstable nature of emotions that influence our decisions. Moreover, these results could have potential important implications for understanding difficulties in interpersonal behavior due to emotion regulation disturbances often observed in a variety of psychiatric disorders and (social) aggression.

Acknowledgments

We would like to thank Lauren Montoya and Joel McAlister for their help in data collection. This research was supported by the Netherlands Organization of Scientific Research (NWO) Rubicon Grant (No. 446.05.003) to M.vt.W., and NIMH MH77058-02 to A.G.S.

References

- Bolton GE, Zwick R. Anonymity versus Punishment in Ultimatum Bargaining. *Games and Economic Behavior* 1995;10:95–121.
- Butler EA, Egloff B, Wilhelm FH, Smith NC, Erickson EA, Gross JJ. The social consequences of expressive suppression. *Emotion* 2003;3:48–67. [PubMed: 12899316]
- Camerer, CF. *Behavioral Game Theory*. New York: Russell Sage Foundation; 2003.
- Davidson RJ, Putnam KM, Larson CL. Dysfunction in the Neural Circuitry of Emotion Regulation--A Possible Prelude to Violence. *Science* 2000;289:591–594. [PubMed: 10915615]
- Delgado MR, Gillis MM, Phelps EA. Regulating the expectation of reward via cognitive strategies. *Nature Neuroscience* 2008;11:880–881.
- Delgado MR, Nearing KI, LeDoux JE, Phelps EA. Neural Circuitry Underlying the Regulation of Conditioned Fear and Its Relation to Extinction. *Neuron* 2008;59:829–838. [PubMed: 18786365]
- Fehr E, Gächter S. Altruistic punishment in humans. *Nature* 2002;415:137–140. [PubMed: 11805825]
- Giuliani NR, McRae K, Gross JJ. The up- and down-regulation of amusement: experiential, behavioral, and autonomic consequences. *Emotion* 2008;8:714–719. [PubMed: 18837622]
- Goldin PR, McRae K, Ramel W, Gross JJ. The Neural Bases of Emotion Regulation: Reappraisal and Suppression of Negative Emotion. *Biological Psychiatry* 2008;63:577–586. [PubMed: 17888411]
- Gross JJ. Antecedent - and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology* 1998;74:224–237. [PubMed: 9457784]
- Gross JJ. Emotion regulation: Past, Present, Future. *Cognition & Emotion* 1999;13:551–573.
- Gross JJ. Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology* 2002;39:281–291. [PubMed: 12212647]
- Gross JJ, John OP. Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology* 2003;85:348–362. [PubMed: 12916575]
- Gross JJ, Munoz R. Emotion regulation and mental health. *Clinical Psychology: Science and Practice* 1995;2:151–164.
- Guth W, Schmittberger R, Schwarze B. An experimental analysis of ultimatum bargaining. *Journal of Economic Behavior and Organization* 1982;3:367–388.
- Harle KM, Sanfey AG. Incidental sadness biases social economic decisions in the Ultimatum Game. *Emotion* 2007;7:876–881. [PubMed: 18039057]
- Harris CR. Cardiovascular responses of embarrassment and effect of emotional suppression in a social setting. *Journal of Personality and Social Psychology* 2001;81:886–897. [PubMed: 11708564]
- Kahneman D, Knetsch J, Thaler R. Fairness and the assumptions of economics. *The Journal of Business* 1986;59:S285–S300.
- Koenigs M, Tranel D. Irrational Economic Decision-Making after Ventromedial Prefrontal Damage: Evidence from the Ultimatum Game. *Journal of Neuroscience* 2007;27:951–956. [PubMed: 17251437]
- Lee TMC, Chan SC, Raine A. Strong limbic and weak frontal activation to aggressive stimuli in spouse abusers. *Molecular Psychiatry* 2008;13:655–656. [PubMed: 18560435]
- Ochsner KN, Bunge SA, Gross JJ, Gabrieli JDE. Rethinking Feelings: An fMRI Study of the Cognitive Regulation of Emotion. *Journal of Cognitive Neuroscience* 2002;14:1215–1229. [PubMed: 12495527]
- Ochsner KN, Gross JJ. Cognitive Emotion Regulation: Insights From Social Cognitive and Affective Neuroscience. *Current Directions in Psychological Science* 2008;17:153–158.

- Ochsner KN, Ray RD, Cooper JC, Robertson ER, Chopra S, Gabrieli JDE, et al. For better or for worse: neural systems supporting the cognitive down- and up-regulation of negative emotion. *NeuroImage* 2004;23:483–499. [PubMed: 15488398]
- Phillips ML, Young AW, Senior C, et al. A specific neural substrate for perceiving facial expressions of disgust. *Nature* 1997;289:495–498. [PubMed: 9333238]
- Pillutla MM, Murnighan JK. Unfairness, anger, and spite: Emotional rejections of ultimatum offers. *Organizational Behavior and Human Decision Processes* 1996;68:208–224.
- Sanfey AG, Rilling JK, Aronson JA, Nystrom LE, Cohen JD. The Neural Basis of Economic Decision-Making in the Ultimatum Game. *Science* 2003;300:1755–1758. [PubMed: 12805551]
- Sokol-Hessner P, Hsu M, Curley NG, Delgado MR, Camerer CF, Phelps EA. Thinking like a trader selectively reduces individuals' loss aversion. *Proceedings of the National Academy of Sciences* 2009;106:5035–5040.
- Thaler RH. Anomalies: The Ultimatum Game. *Journal of Economic Perspectives* 1988;2:195–206.
- Van 't Wout M, Kahn R, Sanfey A, Aleman A. Affective state and decision-making in the Ultimatum Game. *Experimental Brain Research* 2006;169:564–568.
- Wager T, Davidson ML, Hughes BL, Lindquist MA, Ochsner KN. Prefrontal-Subcortical Pathways Mediating Successful Emotion Regulation. *Neuron* 2008;59:1037–1050. [PubMed: 18817740]
- Xiao E, Houser D. Emotion expression in human punishment behavior. *Proceedings of the National Academy of Sciences of the United States of America* 2005;102:7398–7401. [PubMed: 15878990]



Figure 1.
Full Ultimatum Game trial.

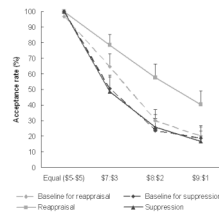


Figure 2. Percentage of acceptance (SE) of the different offers for reappraisal, suppression and their respective baseline conditions separately.

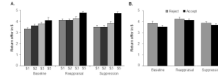


Figure 3. Figure 3A. Amount of return offers in dollars (SE) as proposed by participants as a function of emotion regulation condition and initial offer proposed by participant's partner. 3B. Return offers (SE) as function of participant's decision to accept or reject the offer.