The role of stress in social decision-making.

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Abstract

Obwohl reichlich Literatur zum Thema Auswirkungen von Stress auf soziale Gruppenentscheidungen zurzeit verfasst werden (siehe Mather & Lighthall, 2012), befindet sich die Literatur über Stress und sozialen Gruppenentscheidungen noch in ihren Anfängen. Um die bereits vorhandene Literatur zu erweitern, untersucht diese gegenwärtige Studie leitende Faktoren und Auswirkungen von Stress in sozialen Gruppenentscheidungen. Des Weiteren möchte diese Studie einen neuartigen Ansatz verfolgen, informationsverarbeitende und funktionalistische Perspektiven im Bezug auf akute Stressreaktionen zu vereinen.

Duale Theorien behaupten, dass die emotionale Verarbeitung, die im Gegensatz zur kognitiven Verarbeitung steht, in einer frühen Phase der Informationsverarbeitung einsetzt und mit impulsgeleiteten Handeln assoziiert ist (Mischel & Metcalfe, 1999; Murphy & Zajonc, 1993). Um impulsive Handlungen während akuter Stressreaktionen leichter ausführen zu können, wird wahrscheinlich die emotionale Verarbeitung gesteigert. Während einer Stressreaktion könnte die emotionale Verarbeitung leichteres Eintreten von impulsiven Verhalten bewirken. Frühes Einsetzen von impulsgeleiteten Verhalten kann zur Prävention von lebensgefährlichen Situationen dienen, widerspiegelt also die angeborenen, reizgeleiteten und später inkorporierten und Elemente des Menschen. Dieses Argument beruht auf evolutionären Stress Perspektiven, welche die Funktion des psychologischen Stresses in der Mobilisierung des Körpers zur Handlungsbereitschaft sehen. (e.g., Tsigos & Chrousos, 2002).

Dementsprechend könnte eine verstärkte emotionale Verarbeitung und die Hemmung der kognitiven Steuerung, verglichen zu normalen Gegebenheiten, zu einem früher einsetzendem und impulsiverem Verhalten führen. Außerdem können, als Antwort auf Reize in der Umgebung, jene schnelle und automatisch ablaufenden Verhaltensreaktionen sich in akuten Stresssituationen als nützlich erweisen, wie zum Beispiel in der Prävention von Störungen der Homöostase. Um jene schnellen und automatischen Verhaltensreaktionen zu ermöglichen, könnte während einer akuten Stresssituation die emotionale Verarbeitung gesteigert und die kognitive Verarbeitung gehemmt werden. Empirische Untersuchungen von der Belohnungswahrnehmung (siehe Mather & Lighthall, 2012) oder emotionalem Lernen (Luethi et al., 2008) stützen die Auffassung, dass akuter Stress ein intensiveres Wahrnehmen von jenen emotionalen Phänomenen erzeugt.

Wie auch immer, jene Verbesserung in der emotionalen Verarbeitung kann sich negativ auf soziale Entscheidungsfragen auswirken, so werden beispielsweise negative Emotionen, die sich durch unfaire Behandlung entwickeln können, verstärkt wahrgenommen, wenn sich Menschen in einer Stresssituation befinden. Gestresste Teilnehmer in einem Ulimatumspiel würden vermutlich öfters unfaire Angebote ablehnen als die ungestressten. Diese Arbeit testete diese Haupthypothese und untersuchte Tendenzen zur emotionalen Regulierung bzw. Mäßigung durch mittlere oder leitende Faktoren, im Hinblick auf akuten Stress und Ablehnungen von Angeboten im Ulitmatumspiel. Diese Argumente werden im Kapitel eins, zwei und drei der Dissertation ausgearbeitet.

In zwei Experimenten nahmen die Teilnehmer an einem Ultimatumsspiel als Antwort-gebende teil, nachdem sie entweder eine Stress- oder Kontrollaufgabe erledigt hatten. Der Cold Pressor Test wurde als Methode zur Stressindizierung verwendet. Vor und nach dem Ultimatumspiel gaben die Teilnehmer eine Bewertung ihres emotionalen Bewusstseinszustandes an, sowie die allgemeine Fähigkeit, auftretende Emotionen zu regulieren.

Ergebnisse vom ersten Experiment zeigen eine erfolgreiche Stressinduktion, angedeutet durch einen höheren Cortisolspiegel, verglichen mit der Kontrollgruppe. Außerdem zeigte Experiment 1 einen signifikanten Stress x Anzahl der Interaktionen, mit durchschnittlich höheren Werten (statistisch auf einem nicht relevantem Level) von Ablehnungen unfairer Angebote (im Vergleich zu fairen Angeboten) seitens der gestressten Teilnehmer. Wie auch immer, die Ergebnisse der zwei Befragungen zum emotionalen Bewusstseinszustand wiesen nicht auf zu erwartende Muster hin. Also mit unpassenden korrelierenden Emotionen zur Eigenschaft fair oder zu unfairen Angeboten, wie auch unpassende Ergebnisse zur emotionalen Bewältigung, die sich durch reduzierte Ablehnungen von fairen Angeboten zeigt, keine Reduktion hingegen bei unfairen Angeboten aufweist. Das Experiment 2 wurde so konstruiert, um durch Manipulation negative Emotionen (namentlich die Partnertypen) hervorzurufen. Die Ergebnisse spiegeln nicht die diejenigen des ersten Versuches wieder, ergaben aber neue Ergebnisse zu den Korrelationen bezüglich der negativen Emotionen und des zugeordneten Partners. Teilnehmer, die mit einem menschlichen Partner (also nicht mit dem Computer) zusammengearbeitet haben, lehnten zum einen mehr unfaire Angebote ab, des Weiteren korrelierten in diesem Versuch faire bzw. unfaire

Ablehnungen mit den negativen Emotionen. Die Ergebnisse der Experimente sind im Kapitel 4 beschrieben.

Es ist schwierig felsenfeste Schlussfolgerungen von diesen Ergebnissen zu zeichnen, trotzdem bieten sie einen Startpunkt für zukünftige interessante wissenschaftliche Fragestellungen. Kapitel 5 diskutiert einige Konsequenzen und Verwendungsmöglichkeiten wie auch Grenzen dieser wissenschaftlichen Arbeit.

Abstract

Although a substantial literature is developing regarding the effects of stress on decision-making (cf. Mather & Lighthall, 2012), the literature on stress and social decision-making is still in the beginning stage. The present research extends this new literature by examining the mediating and moderating factors of the effect of stress on social decision-making. Furthermore, a novel aspect of the research is its effort to connect the information-processing and functional perspectives, with regard to the acute stress response.

Dual-mode theories state that emotional processing, relative to cognitive processing, occurs early during information processing (Murphy & Zajonc, 1993) and is associated with stimulus-driven behaviors (Mischel & Metcalfe, 1999). Therefore, an intensification of emotional processing and inhibition of cognitive control processes may lead to an earlier and more stimulus-driven initiation of behavioral responses than under normal circumstances. Moreover, such quick, automatic behavioral responses to environmental stimuli may be particularly useful during an acute stress response in that such responses could help prevent disturbances to homeostasis (Nesse, 2005). In order to facilitate such quick, automatic behavioral responses, emotional processing may be intensified and cognitive processing inhibited, during an acute stress response. In support of this notion, empirical findings show that acute stress increases emotion-related phenomena, such as reward salience (cf. Mather & Lighthall, 2012) and emotional learning (Luethi, Meier, & Sandi, 2008).

However, in a social decision-making context, such enhancement of emotional processing may negatively affect the social interactions, such that negative emotions from perceived unfairness may be amplified when people are undergoing an acute stress response. More specifically, in the context of an Ultimatum Game, people who are stressed may reject more unfair offers than people under normal conditions. This research tested this main hypothesis, and examined emotions and trait emotion regulation tendencies as mediating and moderating factors, respectively, of the relationship between acute stress and Ultimatum Game rejections. These arguments are elaborated in Chapters 1, 2, and 3 of this dissertation.

In two experiments, participants played the Ultimatum Game as the Responder after completing a stress or control task. The Cold Pressor Test was used as the stress induction method. Before

and after the Ultimatum Game, participants completed state emotion ratings as well as trait emotion regulation questionnaires.

Results from Experiment 1 showed a successful stress induction, indicated by higher cortisol levels in the stress, relative to control, group. Moreover, Experiment 1 revealed a significant Stress x Amount interaction, with stress having an effect on rejections of unfair offers, in comparison to fair offers. However, the emotion and emotion regulation results did not indicate the expected pattern, with emotions being uncorrelated with fair, nor unfair offers, and emotion regulation being associated with reduced rejections of fair, but not unfair, offers. In Experiment 2, an experimental manipulation designed to influence negative emotions, namely partner type, was employed. Results did not replicate the results of the first experiment, but unexpected results were found involving partner type and negative emotions, namely that participants who played with human partners, relative to those who played with computer partners, rejected more unfair offers and that negative emotions were positively correlated with rejections of fair and unfair offers. The experiments and their results are described in Chapter 4.

It is difficult to draw firm conclusions from these results, but they do offer a starting point for interesting future research questions. Chapter 5 discusses some implications as well as limitations of the present research.

Contents

Dual-mode theories propose that human cognition and behavior reflect functioning of both reflexive, emotional processing and deliberate, cognitive processing (Chaiken & Trope, 1999; Lieberman, 2007; Metcalfe & Mischel, 1999; Murphy & Zajonc, 1993). According to such theories, emotional processing is strong during the early stages of information processing and is stimulus-driven, whereas cognitive processing is relatively weak during early information processing and may be more controlled (Metcalfe & Mischel, 1999; Murphy & Zajonc, 1993). Furthermore, these two processes are not completely independent, but rather interact with each other (Metcalfe & Mischel, 1999). For example, cognitive processing has been implicated in regulation of emotional processing in many situations, such as impulse control (Rodriguez, Mischel, & Shoda, 1989) and emotion regulation (Ochsner & Gross, 2005; Schmeichel, Volokhov, & Demaree, 2008). Employing a well-established social decision-making task, the current study examines how acute stress shifts the weight between emotional and cognitive processing in the context of social decision-making.

Dual-mode theories have also proposed that quick and stimulus-driven behavioral responses would be adaptive during a stressful situation (Metcalfe & Mischel, 1999). Given these characteristics of adaptive behaviors during an acute stress response, emotional processing may be enhanced during the acute stress response, leading to an early onset of behavioral response. In contrast, it may not be adaptive to employ cognitive processes as they may not allow for a rapid reaction to cope with challenging situations. Consistent with this notion, stress has been proposed to be a factor which enhances emotional processing (Loewenstein & O'Donoghue, 2004; Metcalfe & Mischel, 1999), and recent empirical research supports this claim. For example, acute stress enhances reward-salience (e.g., Lighthall, Gorlick, Schoeke, Frank, & Mather, 2013; Mather & Lighthall, 2012), and activity of brain regions associated with emotional experience (e.g., van Marle, Hermans, Qin, & Fernandez, 2010; see Arnsten, 2009 for a review). In contrast, acute stress inhibits high-order cognitive functions such as working memory (Luethi et al., 2008) and self-regulation (e.g., Shiffman & Waters, 2004) as well as associated brain regions (e.g., prefrontal cortex; Arnsten, 2009). Based on evolutionary views of stress (Nesse, 2005 ; Nesse, Bhatnagar, & Young, 2007), the present paper proposes that behavioral responses which have an early onset and are stimulus-driven should be adaptive during an acute stress response because they can prevent disturbances to homeostasis and automatically generate responses which are appropriate for the eliciting stimuli.

The two types of processing are hypothesized to be differentially associated with decision-making behaviors which involve emotions, such that emotional processing promotes impulsive behaviors, whereas cognitive processing controls and regulates the impulsive responses generated through emotional processes (Loewenstein & O'Donoghue, 2004, 2007; Metcalfe & Mischel, 1999). For example, in the context of social decision-making, emotional processing may influence decisions by inducing a strong impulse to express emotions towards other people (Xiao & Houser, 2005). On the other hand, cognitive processing may control such impulsive responses through control mechanisms supporting emotion-regulation (e.g., working memory; Schmeichel et al., 2008). Trait emotion regulation has also been shown to be associated with the experience and expression of emotions (Gross & John, 2003) as well as with interpersonal functioning (Gross & John, 2003). Therefore, emotional processing may influence social decision-making behaviors, while cognitively-modulated trait emotion regulation may be associated with (but not directly influence) social decision-making behaviors.

The present research builds on previous assertions regarding the relationship between stress and emotional as well as cognitive processing (e.g., Metcalfe & Mischel, 1999) to develop hypotheses about how acute stress will influence these two modes of functioning and their effects on behaviors in a social decision-making task, namely the Ultimatum Game. With stress increasing emotional processing and decreasing cognitive processing, stress may amplify the impact of emotions on Ultimatum Game behaviors, while trait emotion regulation tendencies may moderate this relationship. These hypotheses are tested in two experiments.

Research concerning acute stress and non-social decision-making has accumulated (for reviews of this literature, see Mather & Lighthall, 2012; Starcke & Brand, 2012), but the literature on the effects of acute stress on social decision-making is still in the beginning stage (for a review, see Van den Bos, Jolles, & Homberg, 2013). The present research adds to the latter, relatively new, literature in several ways. First, although previous research has examined effects of acute stress on social decision-making, as well as effects of emotions and emotion regulation on social decision-making, no study seems to have examined emotion and trait emotion regulation as mediating and moderating factors in the relationship between acute stress and social decision-making. The current research examines this relationship in the context of the Ultimatum Game. Second, acute psychosocial stress has been employed in the studies which have so far been conducted concerning acute stress and social decision-making, (Takahashi, Ikeda, & Hasegawa, 2007; von Dawans, Fischbacher, Kirschbaum, Fehr, & Heinrichs, 2012). The present research adds to this literature by examining whether acute physical stressors lead to similar social decision-making behaviors as acute psychosocial stressors. Finally, this paper makes an effort to combine the information processing perspective with the functional perspective, regarding the acute stress response, in order to explain both how and why acute stress influences psychological functioning. In combining the information processing and functional perspectives to explain the effects of the acute stress response on emotional and cognitive processing, this paper adds to previous syntheses of the functional and information processing perspectives (Tooby & Cosmides, 2005; Van den Bos et al., 2013).

Definitions

Throughout this paper, related but different terms will be used to describe processes involved in acute stress response and social decision-making. The term stress describes experiences that are emotionally or physiologically challenging (Mather & Lighthall, 2012; McEwen, 2007). Accordingly, a stress response refers to the physiological and behavioral processes which occur in response to such experiences. Moreover, it should be noted that throughout the paper, there is a distinction between the physiological stress response and the behavioral responses with which they are associated (e.g., fighting or fleeing behaviors). In this paper, the physiological stress response, which is defined by increased sympathetic (and decreased parasympathetic) activity and activation of the hypothalamic-pituitary-adrenocortical (HPA) axis (Charmandari, Tsigos, & Chrousos, 2005; Tsigos & Chrousos, 2002), is supposed to underlie multiple behavioral stress responses. Furthermore, this relatively general physiological response is supposed, in this paper, to serve the function of mobilizing behavioral stress responses in a quick and uncontrolled, stimulus-driven manner.

Second, the terms “early onset of behavioral response” and “stimulus-driven behavioral response” are used throughout the paper. The former term refers to the timing at which a behavioral response is initiated. Furthermore, there is a distinction between an early onset of behavioral response and early information processing. The relationship between the two constructs can be defined such that if a behavioral response is initiated after only the early processes, the behavioral response will have an early onset; whereas if later processes occur after the early processes, the behavioral response will have a later onset. This concept is explained in more detail in Chapter 1.

The latter term mentioned above is not as clearly defined as the former. Stimulus-driven behavioral response refers roughly to automatic (e.g., Bargh, 1994), bottom-up (e.g., Barrett, Ochsner, & Gross, 2007), or reflexive (e.g., Lieberman, Gaunt, Gilbert, & Trope, 2002) behaviors. Such behaviors do not require any other input than the stimulus, and through automatic processes such as spreading activation (e.g., Rumelhart, Hinton, & McClelland, 1986), the stimulus can lead to a behavioral response. This construct is similar to the construct of early onset of behavior in that the stimulus-driven processing also occurs early, but stimulus-driven behavior differs from early onset of behavior in terms of the function it is supposed to serve.

That is, being stimulus-driven may serve the function of automatically identifying an appropriate behavioral response to the eliciting stimulus, whereas early onset of behavior may serve the function of preventing disturbances to homeostasis. This idea is built on previous assertions (Metcalfe & Mischel, 1999), and is also explained in more detail in Chapter 1.

Third, as defined above, emotional and cognitive processing refer to distinct modes of psychological functioning. In this paper, emotional processes include affective evaluations (i.e., judgments of whether a target object is 'good' or 'bad'; e.g., Fazio, 2001), sensitivity and reactivity to rewarding stimuli, and generation of specific emotional states. In contrast, cognitive processes in this paper include higher order processes such as working memory and logical thinking. As argued below, emotional processes, relative to cognitive processes, occur early and are stimulus-driven, whereas cognitive processes, such as working memory and self-regulation, are relatively slow and less stimulus-driven (Barrett et al., 2007; Lieberman et al., 2002; Loewenstein & O'Donoghue, 2004; Metcalfe & Mischel, 1999). Therefore, with less intense cognitive processing and more intense emotional processing, the onset of behavioral responses may occur earlier and be more stimulus-driven and less controlled than under normal circumstances.

Chapter I - Increasing emotional processing while decreasing cognitive processing

The main argument of this chapter is that the basic physiological mechanisms of the acute stress response facilitate early onset of stimulus-driven behavioral response by enhancing emotional processing, relative to cognitive processing. In order to describe empirical support for a link between the physiological mechanisms and early onset of stimulus-driven behavioral responses, this chapter first connects early onset of stimulus-driven behaviors to emotional as well as cognitive processing. After establishing the connection between early onset of stimulus-driven behavioral responses and emotional and cognitive processing, the chapter reviews empirical findings which support the notion that emotional processing is enhanced, but cognitive processing is not, during the acute stress response.

Previous theoretical work has made a connection between stress and emotional processing (Loewenstein & O'Donoghue, 2004; Metcalfe & Mischel, 1999). More specifically, stress has been hypothesized to differentially influence the emotional and cognitive systems, enhancing emotional processing while inhibiting cognitive processing at low and high levels in the manner of the Yerkes-Dodson Law (Yerkes & Dodson, 1908 as cited in Metcalfe & Mischel, 1999). Furthermore, these models suggest that this influence of stress on emotional processes serves an adaptive function, allowing the animal to produce "quick responding driven by innately determined stimuli or stimuli that have been conditioned to produce immediate responding" during acute stress (Metcalfe & Mischel, 1999; p.8). On the other hand, regarding cognitive processing, the same authors suggest that during acute stress, "it is not the time for cognitive complexity or rumination." These arguments have been made in the context of the hot-cool systems approach (Metcalfe & Mischel, 1999) as well as a mathematical model (Loewenstein & O'Donoghue, 2004). These previous arguments provide the basis for the argument presented in this chapter, namely that acute stress intensifies emotional processing, relative to cognitive processing, in order to facilitate behavioral responses which have an early onset and are stimulus-driven.

This chapter is organized in four subchapters. In the first subchapter, in order to show how an acute stress response prepares an animal for physical activity, the physiological mechanisms of an acute stress response are described. Next, the psychological mechanisms which may facilitate early onset of stimulus-driven responses during an acute stress response are described. As explained in this chapter, such mechanisms have been studied in the framework of dual-mode theories that draw a distinction between emotional and cognitive processing (e.g., Metcalfe & Mischel, 1999; Zajonc, 1980, 1984). More specifically, these theories suggest that emotional processing, relative to cognitive processing, occurs early during information processing and is stimulus-driven. Therefore, the second and third subchapters describe these dual-mode theories and supporting empirical findings which suggest that emotional, relative to cognitive, processing occurs early (subchapter 2) and is stimulus-driven (subchapter 3). The conclusion drawn from these subchapters is that a heightened activation of the emotional, as opposed to the cognitive, system should facilitate early onset of stimulus-driven behaviors. In other words, the intensification of emotional processing is the psychological mechanism which facilitates early onset of stimulus-driven behaviors. Moreover, this mechanism occurs during an acute stress response. The fourth subchapter describes empirical support for this conclusion. More specifically, the fourth subchapter describes findings which suggest that acute stress enhances emotional processing, inhibits cognitive processing, and influences the interaction between emotional and cognitive processes as shown by effects of acute stress on emotion and emotion-regulation.

Preparations for activity during an acute stress response

An underlying assumption in this paper is that the physiological mechanisms underlying an acute stress response serve to promote physical actions which aid immediate survival, such as fleeing from or fighting against a predator. This claim has been made in previous works (Nesse et al., 2007; Tsigos & Chrousos, 2002) and will be discussed first. More specifically, this subchapter describes how the physiological mechanisms underlying an acute stress response help prepare an animal for action and simultaneously inhibit vegetative functions.

The physiological mechanisms underlying the acute stress response are carried out by the autonomic nervous system (ANS) and the hypothalamic pituitary adrenal (HPA) axis, with the ANS stress response preceding the HPA axis response (Tsigos & Chrousos, 2002). In the beginning stage of the response, activities of the sympathetic nervous system, the branch of the ANS associated with physical activity, are enhanced. For example, heart rate and contractility increases, leading to enhanced circulation; rate and depth of breathing increases, leading to expedited gas exchange; blood is redirected from gut and skin to muscles; and blood clotting is increased , helping one to recover more easily from injuries (Cannon, 1929 as cited in Nesse et al., 2007). Furthermore, arousal and alertness are enhanced through the release of norepinephrine (NE) and epinephrine by the locus ceruleus (Tsigos & Chrousos, 2002). These mechanisms have been suggested to facilitate action, as opposed to rest (Nesse et al., 2007; Tsigos & Chrousos, 2002).

Similarly to the ANS stress response, during the HPA axis stress response, the body mobilizes for physical action by increasing its metabolic activities (Nesse et al., 2007). More specifically, during the HPA axis stress response, the liver breaks down glycogen into glucose which is used as energy (Munck, Guyre, & Holbrook, 1984). Furthermore, cells are changed so that glucose can enter the cells more easily (Munck et al., 1984). Thus, during an acute stress response, more energy in the form of glucose becomes available, and cells become better equipped to use the energy, mechanisms facilitating physical action (Nesse, 1999). In addition to increased metabolic activity and the resulting increase in available energy, fighting behaviors seem to be enhanced during the HPA axis response. More specifically, stimulation of the hypothalamus, an important part and starting point of the HPA stress response, is associated with aggressive behaviors (Siegel, Roeling, Gregg, & Kruk, 1999). For example, animal research shows that hypothalamic stimulation induces defensive rage as well as more general ‘multi-purpose’ aggression (Siegel et al., 1999). These processes show an animal increasing available energy for potential action, such as fighting, during an acute stress response.

In contrast to the enhancement of physiological mechanisms underlying physical action, physiological mechanisms underlying vegetative states are inhibited during an acute stress response. Empirical support for this claim includes the inhibition of the activities of the parasympathetic nervous system, the branch of the ANS which is associated with vegetative functions (Nesse et al., 2007). The de-activation of the parasympathetic nervous system leads to inhibition of vegetative functions including digestive, reproductive, and growth functions (Nesse et al., 2007). In addition to vegetative functions, information which may distract an animal during a stress response, such as pain and hunger, are suppressed by components of the stress response, namely the beta-endorphin system and corticotropin-releasing hormone (CRH; Tsigos & Chrousos, 2002). More specifically, upon secretion of CRH, beta-endorphins suppress pain by travelling to the pain control neurons of the hind brain and spinal cord (Charmandari et al., 2005)[1]. Appetite is suppressed through influence on the appetite-satiety centers in the hypothalamus (Chamandari et al., 2005). These mechanisms indicate inhibition of vegetative functions and suggest a suppression of information which may distract the animal during an acute stress response.

Similar to the inhibition of parasympathetic nervous system functions, sexual, growth, and immune functions are inhibited during the HPA stress response (for a review, see Charmandari et al., 2005). As described by Charmandari and colleagues (Charmandari et al., 2005), the HPA stress response inhibits growth hormone activity in several ways. First, HPA axis hormones, namely CRH and glucocorticoids, indirectly inhibit target tissues through various intermediary hormones. More specifically, the release of CRH from the hypothalamus stimulates the release of somatostatin, which inhibits the activity of growth hormone (GH). The decrease in growth hormone activity then reduces activity of the insulin-like growth factor I (IGF-I), which then reduces the development of target tissues. Furthermore, glucocorticoids released by the adrenal gland simultaneously inhibit growth hormone activity and target tissues. These mechanisms suggest that vegetative functions, such as growth functions, are suppressed during the HPA stress response.

While enhancement of action and suppression of vegetative functions may facilitate physical activities needed during an acute stress response, such mechanisms may have maladaptive consequences as well, especially in the long-run. For example, prolonged suppression of growth functions can manifest physically, for example, as short stature (Charmandari et al., 2005), and prolonged suppression of sexual functions can be detrimental to reproduction abilities, leading to low testosterone levels in males and in females, amenorrhea (Charmandari et al., 2005), the absence of menstrual periods. Therefore, the physiological

[1] Pain is a particularly interesting function in that although it is suppressed during an acute stress response, it could also be a stimulus which initiates an acute stress response (e.g., Cold Pressor Test; Bullinger et al., 1984). The distinction between pain as a stressor and pain as a function which is suppressed during stress may be that, while pain is a useful function designed to protect an animal from tissue damage (Nesse, 1999), once an acute stress response has been initiated, pain may no longer serve a useful purpose for the animal's survival, instead, distracting the animal and making it more difficult to focus on its survival strategy.

mechanisms underlying an acute stress response appear to especially enhance short-term, relative to long-term, survival.

To summarize, the physiological mechanisms of an acute stress response indicate a preparation for physical action as opposed to rest. More specifically, physiological systems and hormonal activities which support action, such as the sympathetic nervous system and glucocorticoid activity, are enhanced during a stress response; whereas systems and hormones associated with vegetative functions, including the parasympathetic nervous system and growth hormone, are inhibited (Charmandari et al., 2005; Nesse et al., 2007; Tsigos & Chrousos, 2002). Having discussed this basic assumption of the paper, the next subchapter elaborates the first main argument of this chapter, namely that early onset of behavioral responses during an acute stress response is facilitated by emotional, relative to cognitive, processing.

Increasing speed through emotional processing

This subchapter explains the notion of “affective primacy,” which states that emotional processes, relative to cognitive processes, dominate early information processing (Murphy & Zajonc, 1993; Zajonc, 1980, 1984). The subchapter first describes empirical findings, in particular, from the affective priming paradigm, which suggest that emotional processing, relative to cognitive processing, dominates the early stage of information processing. Next, empirical findings are described suggesting that cognitive processes occur after emotional processing. An implication of the affective primacy is that behavioral responses based primarily on emotional processing would have an earlier onset than behavioral responses which occur after cognitively modulated control processes modify the initial response based on emotional processing.

Dual-mode theories of psychological functioning (e.g., Metcalfe & Mischel, 1999; Zajonc, 1980, 1984) have drawn a distinction between emotional and cognitive processing. According to these theories, in the early stages of information processing, emotional processing is stronger than cognitive processing, a phenomenon which has been called ‘affective primacy’ (Zajonc, 1984). The affective priming experimental paradigm (Murphy & Zajonc, 1993) provides an illustration of this hypothesis. In this paradigm, participants were shown either suboptimal (4 millisecond duration) or optimal (1000 ms duration) images of happy or angry faces before being shown a novel stimulus (i.e., an unknown Chinese ideograph). After seeing the prime and the novel stimulus, participants rated how much they liked the novel stimulus (Murphy & Zajonc, 1993). The results showed that suboptimal affective primes (i.e., the faces), but not optimal affective primes, led to ratings of the novel stimulus which were congruent with the affective valences (i.e., negative or positive) of the primes. That is, when participants had only four msec to process an emotional prime, the prime reliably influenced the affective judgment of a subsequent novel stimulus; whereas this effect did not occur when more time was given to process the emotional prime. This result was interpreted as meaning that affective processing is stronger than cognitive processing during the very early stages of processing (Murphy & Zajonc, 1993; p.727).

Not only do empirical findings suggest that early processing is dominated by emotional processing, but the findings also suggest that cognitive processes, such as identification of a stimulus, do not occur as early as emotional processes. For example, in the affective priming paradigm (Murphy & Zajonc, 1993, pp. 725-726), participants were given a memory task, in which they were first shown the prime stimulus for four msec, and then shown two faces, one which was identical to the prime stimulus just shown, and another which was different from the prime stimulus. In this task, participants could only correctly identify the prime stimulus, on average, 5.78 times out of 12 trials. This finding has been interpreted to mean that although participants could determine the affective value of the prime stimulus during the four msec, they could not yet identify the stimulus during the same amount of time (Murphy & Zajonc, 1993; p.727). Therefore, the cognitive process of stimulus identification may occur later, and not yet at the time that affective processing does.

Neuroanatomical findings involving the neural systems underlying emotional and cognitive processes provide further support for the claim that affective processing, relative to cognitive processing, dominates early information processing. More specifically, researchers have found a connection between the thalamus, the sensory relay center, and amygdala, a brain region strongly associated with the processing and expression of emotions (LeDoux, 2003), with a length of only one synapse (LeDoux, Iwata, Cicchetti, & Reis, 1988). In contrast, the connection between the thalamus and hippocampus, a brain region associated with episodic memory functions (Phelps, 2004), is several synapses long (Murphy & Zajonc, 1993). Therefore, the sensory information from the thalamus can travel to the amygdala more quickly than it can to the hippocampus, suggesting that the amygdala can respond to a stimulus before the hippocampus can (Murphy & Zajonc, 1993). Such early emotional processing may enable a response at an earlier point in time than cognitive processing can (Murphy & Zajonc, 1993, p. 737).

This characteristic of emotional processing may be adaptive during an acute stress response, because the affective information regarding a stimulus (e.g., "this stimulus is bad") could enable an earlier response to the stimulus if the information is obtained early. In turn, the early onset of a behavioral response to the stimulus (e.g., a stalking lion), based on early affective judgments, may help to prevent a disturbance from the stimulus. Put differently, during an acute stress response, the early emotional processes may be strengthened, and the later cognitive processes may be weakened, leading to an earlier initiation of a behavioral response to the stressor.

To summarize, in theories distinguishing between emotional and cognitive processing, emotional processing, relative to cognitive processing, is supposed to dominate early information processing. This claim is supported by empirical findings from the affective priming paradigm (Murphy & Zajonc, 1993), as well as neurological studies (e.g., LeDoux et al., 1988). The strong emotional influence on early stages of processing suggest that emotional processing, relative to cognitive processing, may enable early onset of behavioral responses (Murphy & Zajonc, 1993) to an acute stressor.

Stimulus-driven processing is associated with emotional processing

As with early onset of behavioral responses, automatic, stimulus-driven behavioral responses should be adaptive during an acute stress response. The rationale for this argument is that, as suggested by Metcalfe and Mischel (Metcalfe & Mischel, 1999; p.8), such behavioral responses may be driven by adaptive unconditioned or conditioned stimulus-response links activated by the stimulus in question. Such stimulus-response links may have been shaped through natural selection, or learned during one's lifetime, but in either case, they may serve as adaptive shortcuts regarding the behavior to produce in response to a specific stimulus. This subchapter describes how stimulus-driven behavioral responses may be enhanced, for example, during an acute stress response. The main argument of the subchapter is that without control processes, an emotional response can take place automatically with only the stimulus as input.

Empirical support for the argument, in particular, findings from the delay of gratification paradigm, is described.

The hot-cool systems theory (Metcalfe & Mischel, 1999) draws an explicit connection between the 'hot' emotional system and stimulus-driven behaviors. In this model, the "hot emotional system is specialized for quick emotional processing and responding on the basis of unconditional or conditional trigger features" whereas the "cool cognitive system is specialized for complex spatiotemporal and episodic representation and thought" (Metcalfe & Mischel, 1999; p. 4). According to this theory, the hot system, comprised of "hot spots" with little interconnectivity with each other, is stimulus-driven in that upon perception of a hot stimulus, the activation of hot spots leads to the initiation of an impulsive behavioral response (Metcalfe & Mischel, 1999). In other words, in the presence of a hot stimulus, the 'default' response is driven by the stimulus and mediated by activation of hot spots. Importantly, the hot system is associated with emotional, as opposed to cognitive, processing (Metcalfe & Mischel, 1999). Similarly to the hot-cool systems approach, the 'modal model' of emotion (Barrett et al., 2007) also suggests that emotions are associated with automatic, stimulus-driven behavioral response. More specifically, the modal models of emotion suggest that emotional responses are themselves automatically elicited by stimuli (Barrett et al., 2007). Of the modal models of emotion, the basic emotion theories (e.g., Ekman, 1972) posit that certain basic emotions (e.g., anger, fear, happiness, sadness, disgust) are automatically triggered by specific stimuli, and lead to corresponding physiological and behavioral responses (Barrett et al., 2007; p. 178). An important idea underlying the basic emotion theories is that emotions occur through hardwired neural circuits which are automatically activated upon perception of an eliciting stimulus (Ekman, 1972).

In contrast to the hot system, the cool system is comprised of highly interconnected "cool nodes" which can modify the default response generated by the hot system (Metcalfe & Mischel, 1999), leading to a more controlled response. The hot spots and cool nodes are hypothesized to be interconnected, with activation of hot spots leading to activation of cool nodes and vice versa (Metcalfe & Mischel, 1999). Similarly, in the basic emotion theories, after an emotional response is generated, cognitive control processes can intervene and modify the emotional response (Barrett et al., 2007; pp. 178-179). In short, the theories discussed above state that by default, responses to ‘hot’ stimuli are emotional, but those emotional, impulsive responses can be modified by later cognitive control processes.

The activities of the hot and cool systems, as well as their interactions can be illustrated by behaviors exhibited during the delay of gratification paradigm (Mischel, Ebbesen, & Zeiss, 1972). In this experimental paradigm, children between ages three and five were offered two rewarding stimuli (i.e., a marshmallow or a pretzel), and indicated their preferred reward. In the context of the hot/cool systems model (Metcalfe & Mischel, 1999), the preferred reward is the ‘hot stimulus’ which activates the hot spots. The children were informed that if they waited for the experimenter to come back to the room, the preferred stimulus would be given to them, but if they chose to bring the experimenter back earlier by ringing a bell, they could receive the other object, but not the preferred object. Importantly, some children were given distractor activities, including playing with a toy (external distractor) or thinking of entertaining things (internal distractor), while others were simply told the instructions for waiting with no mention of distractors. In the context of the model (Metcalfe & Mischel, 1999), the distractors may activate cool nodes which control the activity of hot spots, allowing the child to wait for the preferred reward. Results from the study showed that indeed, without distraction, children could not wait for the experimenter to come back, and took the not-preferred reward after waiting an average of only 0.5 minutes. In contrast, children waited on average between 8-12 minutes when a distractor was available (Mischel et al., 1972). These results seem to support the notion that impulsive, stimulus-driven behavioral response is the default, when in the presence of a hot stimulus, but that this default response can be modified by cool cognitive strategies such as distraction.

The stimulus-driven processes through which impulsive behavioral responses may occur have been specified in greater detail (Barrett et al., 2007) in the context of the parallel distributed processing (PDP) framework (e.g., Rumelhart et al., 1986). In the PDP framework (e.g., Rumelhart et al., 1986), upon input of the stimulus, units analogous to neurons in the brain become activated, spreading the activation through the units to which they are connected (Rumelhart et al., 1986). Spreading activation proceeds automatically upon perception of the stimulus, and is therefore stimulus-driven without ‘top-down’ control. This spreading of activation is constrained only by the activation levels of the units to which it is connected (a mechanism called parallel constraint satisfaction; Lieberman et al., 2002).

There are supposed to be two stages of emotional processing which proceed through spreading activation, namely constraint matching and constraint interpretation (Barrett et al., 2007). In constraint matching, the representation of the stimulus is matched with one from perceptual memory to determine whether the stimulus is familiar or not (Barrett et al., 2007). Moreover, the affective evaluation of the stimulus, that is, whether the stimulus is good or bad, is determined during constraint matching, resulting in the establishment of a general affective state (Barrett et al., 2007). This stage is supposed to involve brain regions related to fear (i.e., amygdala) and reward (i.e., striatum; Barrett et al., 2007), both constructs which are related to emotions. Then, during constraint interpretation, the stimulus is categorized, and representations of the emotional states likely to ensue from the stimulus are activated, and a more specific emotional episode can ensue (Barrett et al., 2007; pp. 196-198). In sum, through the parallel processes of constraint matching and constraint interpretation, an affective state and an emotional episode can arise with the stimulus as input and no control. Moreover, without modification by cognitive control processes, the emotion generated through stimulus-driven processes gains access to action planning (Barrett et al., 2007). Therefore, this model seems to support the notion that stimulus-driven processing, underlying the generation of emotion, can lead directly to a behavioral response, if there are no subsequent control processes.

As mentioned above, stimulus-driven processing directly leads to an emotional response, given that control processes do not intervene. This claim begs the question of under which circumstances control processes come into play. Control processes may modify the initial representations generated under several circumstances. For example, constraint seeking may come into play if there is a conflict between multiple representations or if existing goal states constrain the representations further (Barrett et al., 2007). In Lieberman and colleagues' model (Lieberman et al., 2002) as well, serial processes are supposed to detect conflicts, place additional constraints on the perceived object, and help one to remember previous times when such control was required. Under such circumstances, the initial stimulus-driven representation is supposed to be modified before the final behavioral response is initiated. Importantly, these processes are associated with brain regions which are closely related to cognitive functions such as working memory (i.e., prefrontal cortex) and episodic memory (i.e., hippocampus; Lieberman et al., 2002). These arguments seem consistent with the model of Metcalfe and Mischel

(Metcalfe & Mischel, 1999), which states that emotional processes are the default, and that the initial impulsive responses can be controlled at a later stage by cognitive processes.

It should be noted that although the hot-cool systems approach and basic theories of emotion posit that emotional responses are stimulus-driven, other theories do incorporate controlled cognitive processes into the generation of emotions and emotional responses. More specifically, appraisal theories of emotion (e.g., Frijda, 1988) assert that cognitive processes which interpret the meaning of a situation are a crucial part of emotion generation. In these theories, emotional responses are a result of the cognitive interpretation of a stimulus event, in particular, with respect to the relevance that the stimulus event has to the self (Barrett et al., 2007).

The main argument of this subchapter is that stimulus-driven behavioral responses are associated with emotional processing. More specifically, the automatic link between stimulus and response is mediated by emotion. This claim has been stated or suggested in many previous theories. The most explicit statement of this claim is made in the hot/cool systems theory (Metcalfe & Mischel, 1999), which states that a ‘hot stimulus’, or a rewarding stimulus, activates hot spots, and leads to a default, impulsive behavioral response. This default response to the stimulus, mediated by the emotional system, can be modulated by the cognitive system, or more specifically, by cognitive control strategies. The hot-cool systems approach and the emotion theories both argue that without control processes, an emotional response can take place through purely stimulus-driven processes, such as spreading activation (Barrett et al., 2007). In the modal model theories of emotion (e.g., Ekman, 1972; Frijda, 1988) as well, the stimulus is directly linked to an emotion, which then leads to a response. Unlike the hot system, the cognitive system can modify the initial default response (Metcalfe & Mischel, 1999). These theories suggest that without modulation by the cognitive system, a stimulus-response link, mediated by emotional processes, would be carried out. Based on these arguments, the present subchapter argues that stimulus-driven behaviors are associated with emotional processing.

Influence of stress on the hot system, the cool system, and their interaction

In the present chapter, so far, it has been concluded that emotional processes start earlier than cognitive processes, and can occur through only stimulus-driven processes without top-down control. Therefore, during an acute stress response in which early onset of stimulus-driven behavioral responses are assumed to be adaptive (see page 16 of this chapter), emotional processes may be enhanced, relative to cognitive processes. The purpose of this subchapter is to present empirical support for this hypothesis.

Before presenting the empirical findings, laboratory methods of stress induction will be briefly described. Empirical support (described in detail later in this subchapter) for the argument that acute stress increases emotional processing while decreasing cognitive processing come mainly from studies using two types of stress induction – the Cold Pressor Test (CPT; Bullinger et al., 1984), a physical stressor, and the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993), a psychosocial stressor. The CPT is a physical stressor, where stress is induced by immersing one's hand in ice water (0-3 degrees Celsius) for an extended period of time (e.g., three minutes; Lighthall, Mather, & Gorlick, 2009). The TSST is a psychological stress task, where participants are required to do a task (e.g., giving a speech) in front of multiple judges (cf. Kirschbaum et al., 1993). In contrast to the CPT, this task contains element of social evaluation and has been shown to produce stronger physiological stress responses than the CPT (McRae et al., 2006).

Emotional processes during an acute stress response

Empirical findings concerning the effect of acute stress on reward (and risk) salience and emotional experience are consistent with the claim that emotional processing is enhanced during an acute stress response. First, findings on reward salience indicate that acute stress influences sensitivity to reward and risk, in the context of risk-taking (e.g., Lighthall, Mather, & Gorlick, 2009; Lighthall et al., 2013) as well as learning (e.g., Lighthall et al., 2013; Petzold, Plessow, Goschke, & Kirschbaum, 2010). For example, participants who experienced an acute physical stressor, namely the CPT, compared to those in a control condition, showed different responses in a measure of risk-taking behavior (i.e., balloon analogue risk task; Lejuez et al., 2002), with men becoming more risk-seeking and women becoming less risk-seeking under stress (Lighthall et al., 2009; Lighthall et al., 2013). From these results, the authors concluded that acute stress may amplify existing sex differences in sensitivity to reward and risk (Lighthall et al., 2009).

With regard to reward-based learning, studies employing both physical and psychosocial acute stressors found that stressed participants learned better from positive feedback than non-stressed participants (Lighthall et al., 2013; Petzold et al., 2010). More specifically, after completing a physical stress task or a control task, participants saw novel stimuli (i.e., unknown Japanese characters) which were associated with either positive or negative feedback (Lighthall et al., 2013). Then, in a test phase, participants had to choose stimuli which were associated with positive feedback, while avoiding those which were associated with negative feedback. Results showed that stressed participants, compared to non-stressed participants, chose more correct positive-feedback stimuli. This pattern of results was also found with a psychosocial stressor (Petzold et al., 2010), suggesting that acute stressors can enhance associative learning with rewarding stimuli. Furthermore, avoidance of no-longer rewarding stimuli was impaired in stressed participants (Schwabe & Wolf, 2009), suggesting that the impact of reward lasts longer under stress, than under normal conditions. More specifically, participants first learned behaviors to obtain two types of food, and even after becoming satiated with one of the foods, stressed participants still continued to perform the behavior associated with that food (Schwabe & Wolf, 2009). In other words, although non-stressed participants quickly learned that the association between the behavior and rewarding stimulus had ended, stressed participants' association between the reward and behavior persevered longer. These findings were interpreted to mean that acute stress can result in a bias towards potential rewards (Mather & Lighthall, 2012). Finally, in addition to behavioral findings concerning stress and reward-related behaviors, neurological findings suggest that acute stress influences activity of brain regions associated with reward, such as the striatum (Lighthall et al., 2013). Together, these findings suggest that acute stress may enhance the salience of reward in learning. More generally, these findings seem to suggest that acute stress may increase the impact of 'hot' stimuli on psychological mechanisms.

In the hot-cool system framework, hot representation of a stimulus activates "affect and emotional reactions related to that stimulus" (Metcalfe & Mischel, 1999; p. 7). Accordingly, if acute stress enhances hot system activity, an increase may be observed in the emotional experience and responses to 'hot' stimuli presented after the stressor. Empirical findings from an experimental study (Luethi et al., 2008) concerning emotion learning support this claim. As with reward-related stimuli, stress has been shown to influence subsequent emotional learning. More specifically, participants in the stress condition completed a psychosocial stress task (i.e., TSST) and then learned associations between neutral stimuli (i.e., Pokemon characters) and positive and negative stimuli (i.e., positively valenced words/pictures or negatively valenced words/pictures). In a subsequent test phase, participants rated the Pokemon characters in terms of positive or negative valence. Results showed that stressed participants, relative to control participants, gave more negative ratings to the novel stimuli with negative associations, suggesting that they had learned negative associations better than non-stressed participants (Luethi et al., 2008). Furthermore, previous research (Korte, De Boer, Kloet, & Bohus, 1995) suggests that not only emotional learning, but also emotional behaviors are affected by acute stress. More specifically, animals which had been given glucocorticoid receptor (GR) antagonists, which reduce the binding of the stress hormone to its receptors, displayed less anxious behaviors (i.e., spent more time in open arms of a maze) than stressed animals who had not been given the antagonists (Korte et al., 1995). Together, these findings suggest that acute stress influences both emotional learning and expression.

In addition to responding differently to stimuli seen after stress, stressed participants also showed differences in subjective emotions and emotion-related brain regions after exposure to acute stressors. In an experiment with stressful cues, alcohol-related cues, and neutral cues, participants who saw guided imagery of a personalized stressful past event[2], relative to those who saw neutral cues, subsequently reported significantly greater negative emotions and anxiety, as well as significantly lower positive emotions (Sinha et al., 2008). In another study, participants reported feeling greater anxiety after a high-stress task (i.e., a mental arithmetic task) than after a low-stress control task (Wang et al., 2005). In addition to the self-reported anxiety, the high-stress task was associated with increased activity in the ventral right prefrontal cortex (RPFC), a brain region associated with negative emotions as well as vigilance (Wang et al., 2005). Based on these findings, the authors suggested that acute stress induces negative emotion and vigilance. Furthermore, the activity of the amygdala, another brain region associated with negative emotions such as fear and anxiety, is increased by high levels of catecholamines, the stress chemicals released during the ANS phase of an acute stress response (Debiec & LeDoux, 2006 as cited in Arnsten, 2009). Glucocorticoids, released by the adrenal gland during the HPA axis response, also play an important role in emotional experience. For example, glucocorticoids

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[2] The personalized stressful events were created by asking participants to describe a recent past stressful event, and the stressful events used for cues were rated eight or above on a 10-point scale (*1=not at all stressful, 10=the most stress they felt recently in their life*). Participants in the stress condition, relative to the neutral condition, showed more behavioral distress responses including muscle twitching, muscle tremor, restlessness, muscle tension, muscle ache, headache, quickened breathing, yawning, talking/facial movements, crying, sweating, and stomach/abdominal changes.

were shown to attach to melanocorticoid receptors (MRs) in the limbic brain regions including the amygdala, and inhibition of these receptors reduced fear-motivated immobilization in rats (Korte et al., 1995), suggesting that glucocorticoid activity in limbic regions may contribute to fear-motivated immobility.

Finally, correlational findings further suggest an association between stress and emotional experience. For example, in a diary method study, acute stressors were found to be associated with higher negative affect and lower positive affect (Smyth et al., 1998). In another study, daily stressors explained more than 20% of the variance in emotional experience, including anxiety, hostility, and depression (Bolger, DeLongis, Kessler, & Schilling, 1989). Furthermore, high and low levels of cortisol[3], an important stress hormone, were associated with negative and positive affect, respectively, suggesting a link between a physiological stress response and emotions (Smyth et al., 1998).

In sum, these findings show that stress influences emotion-related processing of stimuli encountered after exposure to an acute stressor. Acute stress influences sensitivity of and associative learning involving hot, reward stimuli (e.g., Lighthall et al., 2009; Petzold et al., 2010). Moreover, acute stress influences associative learning with emotionally valenced stimuli as well as emotional expression (e.g., Korte et al., 1995; Luethi et al., 2008). In addition, emotional experience has been shown to be influenced by and associated with stress (e.g., Sinha et al., 2008; Smyth et al., 1998). So this seems to support the notion that emotional processing is enhanced during an acute stress response. Next, empirical findings regarding the influence of acute stress on cognitive processing are discussed.

<u>Cognitive mechanisms during an acute stress response</u>

As argued above, whereas emotional processing may be enhanced during an acute stress response, cognitive processing, due to their slow and effortful nature, may not be adaptive during an acute stress response and therefore may not be enhanced and even inhibited. Empirical findings from studies investigating the effects of acute stress on higher cognitive processes such as cognitive flexibility and working memory seem to support this argument.

[3] Emotions were reported 25 minutes before the cortisol sampling.

Behavioral studies have shown that higher-order cognitive processes are inhibited by acute stress (Alexander, Hillier, Smith, Tivarus, & Beversdorf, 2007; Luethi et al., 2008). For example, cognitive flexibility has been shown to be affected by acute psychosocial stress (Alexander et al., 2007). To describe in more detail, using the TSST (Kirschbaum et al., 1993) as the stressor, cognitive flexibility, measured with the Compound Remote Associates test[4] (Bowden & Jung-Beeman, 2003), was decreased when participants were stressed relative to when they were not. Furthermore, differences in cognitive flexibility under acute stress and no stress disappeared when subjects were given propranolol[5], a beta-adrenergic antagonist which blocks receptors for norepinephrine (Alexander et al., 2007). These findings suggest that acute stress decreases cognitive flexibility, and that this effect may be mediated by the actions of norepinephrine, an important neurotransmitter in an acute stress response.

Working memory, or the ability to temporarily store as well as to update and manipulate the stored information (Baddeley, 2001), is another cognitive process which is affected by acute stress. In a study involving multiple measures of working memory, acute stress induced by the CPT impaired performance on the O-Span and digit span backward task, relative to a control condition (Schoofs et al., 2009). Since these tasks measure executive function, that is, the ability to operate on stored information, these finding suggest an impairment of this specific working memory function during an acute stress response. Furthermore, performance on these tasks was negatively correlated with cortisol (Schoofs et al., 2009), an important stress hormone, suggesting that physiological mechanisms underlying the stress response are associated with psychological effects of stress. The detrimental effect of acute stress on higher cognitive functions was also found with the stressor being the TSST (Kirschbaum et al., 1993). More specifically, working memory, measured with a modified reading span task, was impaired in the stress condition, relative to the no-stress condition (Luethi et al., 2008). These results seem to support the general argument that stress does not enhance cognitive processing.

In addition to the cognitive processes, acute stress has been negatively associated with the activity of the prefrontal cortex (Qin, Hermans, van Marle, Luo, & Fernandez, 2009; Sinha, Lacadie, Skudlarski, & Wexler, 2004), a brain region which is associated with higher cognitive

[4] It is noteworthy that in these tasks, no emotional stimuli were used, whereas in the studies mentioned above, emotionally valenced stimuli were used in the tasks.
[5] Participants were given propranolol before exposure to the stressor.

functions such as working memory (Qin et al., 2009) and cognitive flexibility (Rougier, Noelle, Braver, Cohen, & O'Reilly, 2005). In addition to working memory and cognitive flexibility, the prefrontal cortex has also been associated with keeping goals and progress toward goals in mind (Lieberman et al., 2002), suggesting that when acute stress disrupts prefrontal cortex activity, goal-oriented, purposive behaviors may also be disrupted. Furthermore, the prefrontal cortex contains many glucocorticoid receptors (Meaney & Aitken, 1985; Patel, Katz, Karssen, & Lyons, 2008; Patel et al., 2000; Perlman, Webster, Herman, Kleinman,& Weickert, 2007 as cited in Schoofs et al, 2009), suggesting that glucocorticoid activity during acute stress may be associated with the impact of acute stress on higher cognitive functions.

To summarize, this section discussed empirical support for the argument that cognitive processes are not enhanced, and potentially inhibited, by acute stress. This argument has been supported by findings that acute stress (both physical and psychosocial) diminishes higher cognitive functions, such as cognitive flexibility and working memory (e.g., Alexander et al., 2007; Schoofs et al., 2009). Furthermore, research has shown negative associations between acute stress and a brain region related to higher cognitive processes (i.e., prefrontal cortex; Qin et al., 2009; Sinha et al., 2004). These empirical findings support the argument that cognitive processing is not enhanced by acute stress.

Interactions between emotional and cognitive processing during an acute stress response

Emotional and cognitive processes interact, and one intersection of their interaction is emotion regulation, whereby cognitive and behavioral strategies regulate the experience and expression of emotions. Empirical findings have demonstrated that both experimental induction of emotion regulation strategies and individual differences in emotion regulation tendencies are associated with emotional responses. Therefore, trait emotion regulation tendencies may moderate the relationship between stress and emotions, as well as stress and social decision-making. On the other hand, however, stress could also adversely affect momentary emotion regulation abilities by reducing cognitive functions which facilitate emotion regulation.

Emotional and cognitive processing are supposed to be interconnected and to interactively influence behaviors (e.g., Metcalfe & Mischel, 1999). Emotion regulation (Gross, 1998; Koole, 2009) is an intersection of emotional and cognitive processing in that emotion regulation strategies are facilitated by cognitive processes (e.g., Schmeichel et al., 2008). Emotion regulation is defined as "the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (Gross, 1998),[6] and includes several emotion regulation strategies (see Webb, Miles, & Sheeran, 2012 for a review). Two well-studied emotion regulation strategies include reappraisal, which involves "changing how we think about a situation in order to decrease its emotional impact," and suppression, which involves "inhibiting ongoing emotion-expressive behavior" (Gross, 2002). These emotion regulation strategies (as well as others) have been shown to be associated with emotional responses in many studies (for reviews, see Aldao, Nolen-Hoeksema, & Schweizer, 2010; Augustine & Hemenover, 2009; Webb et al., 2012). For example, participants who were shown aversive visual images (e.g., people crying, dead animals) reported significantly lower negative affect on trials where they received reappraisal instructions to "reinterpret the content of the picture so that it no longer elicited a negative response," compared to when they were asked to naturally experience their emotions (Phan et al., 2005). Furthermore, reappraisal was found to have a larger effect (d_+=0.36), compared to suppression[7] (d_+=0.16; for a meta-analytic review, see Webb et al., 2012).

Not only experimental, but also individual difference studies have shown that people can effectively regulation their emotions. More specifically, individual differences in long-term tendencies to engage in specific emotion regulation strategies (e.g., reappraisal and suppression) are associated with emotion-related outcomes, such as the tendency to experience and express positive and negative emotions (Gross & John, 2003). Furthermore, this research shows that different emotion regulation strategies are differentially associated with patterns of emotional responses. For example, it was found that reappraisal was positively correlated with the experience and expression of positive emotions, whereas it was negatively correlated with the

[6] Emotion regulation strategies, divided into two broad categories of antecedent and response-focused processes, include situation selection, situation modification, distractivity and concentration (attentional deployment processes), reappraisal (cognitive change process), and suppression of emotion (behavioral modulation process; Gross, 2003; Gross & Thompson, 2007).

[7] A recent meta-analysis (Webb et al., 2012) has found that reappraisal and suppression respectively have small-to-medium and small effects on emotion regulation. Suppression decreases behavioral expression, but tends to increase physiological responding. For example, using a short film showing an amputation to elicit disgust, Gross (1998) asked participants to think about the film in a way that they would not feel anything or to hide their emotional response to the film. Results showed that both strategies lowered disgust expression, relative to a control (i.e., "watch") group, but that sympathetic response and experience of disgust was higher in the suppression condition than in the reappraisal condition. Furthermore, in contrast to findings with negative emotions, suppression has been shown to effectively decrease the experience of positive emotions (Gross & Levenson, 1997).

experience and expression of negative emotions (Gross & John, 2003). Suppression showed a different pattern, however, with people experiencing greater negative emotions and less positive emotions, as well as less expression of negative emotions, with higher suppression (Gross & John, 2003). Research has also shown that reappraisal and suppression are differentially associated with psychopathology (Aldao et al., 2010), for example, with trait anxiety and depression (Dennis, 2007). In sum, both experimental and correlational studies show that emotion regulation can effectively modify emotion-related outcomes and correlational studies suggest that trait reappraisal and suppression are differentially associated with emotion-related outcomes.

In the context of the present research, this influence of emotion regulation on emotional responses suggests that emotion regulation may be able to moderate the effect of stress on emotions and subsequent social decisions. However, it may also be that emotion regulation abilities may be changed due to stress, because stress has a detrimental effect on cognitive processes which facilitate emotion regulation. For example, of the factors discussed in the previous section, working memory may be one cognitive component which facilitates the regulation of emotions. Support for this claim comes from a study in which participants' working memory, measured with the O-Span task, was negatively associated with the expression of emotions (disgust and amusement) in response to video clips (Schmeichel et al., 2008). In the same study, the experience of emotions (disgust, amusement, and sadness) was also negatively associated with working memory (measured with the O-span task and spatial and verbal 2-back task). These findings suggest that working memory is negatively associated with the expression and experience of emotions, suggesting that working memory aids the regulation of emotional expression and experience. Given that acute stress reduces working memory capacity, as the previously discussed findings suggests, acute stress may reduce the regulation of emotion as well. Therefore, even people with high emotion regulation capacities might not be able to control their emotions very well if they are stressed.

Recent findings suggest a link between stress and emotion regulation. For example, self-reported stress has been positively correlated with maladaptive coping strategies (e.g., self-blame, blaming others, rumination, and catastrophizing) and negatively correlated with adaptive ones (e.g., positive refocus, positive reappraisal; Martin & Dahlen, 2005). Moreover, a number of studies indicated that prefrontal cortex, which is significantly impaired by stress as discussed above, plays a crucial role in emotion regulation (for reviews, see Ochsner & Gross, 2005; Quirk & Beer, 2006). For example, in a within-subject design, participants saw highly aversive pictures and were instructed to 'maintain' and 'reappraise' the emotion the picture induced (Banks, Eddy, Angstadt, Nathan, & Phan, 2007). Results showed that in the Reappraise blocks, successful emotion regulation, measured by self-reported negative emotion, was predicted by the connectivity between amygdala and mPFC as well as orbitofrontal cortex (Banks et al., 2007). These results suggest that the mPFC may down-regulate the activity of the amygdala, resulting in successful emotion regulation. In turn, the link between emotion regulation and mPFC activity was moderated by chronic cortisol levels (Urry et al., 2006). More specifically, in participants who were asked to decrease, increase, or attend to negative pictures, mPFC activity was negatively correlated with subjective negative emotion and amygdala activity. Importantly, participants showing less down-regulation of amygdala activity by the mPFC showed flatter diurnal cortisol slopes, which is related to stressful events (Urry et al., 2006). These findings seem to indicate a negative association between stress and emotion regulation. Furthermore, activity of the vmPFC, which is positively associated with emotion regulation, is reduced by high levels of catecholamines (i.e., epinephrine and dopamine), which are released during an acute stress response (Arnsten, 2009).

This subchapter presented empirical findings supporting the argument that stress should increase emotional, but not cognitive, processing. Specifically, findings were described, which show that stress increases reward sensitivity and learning, as well as emotional learning and expression. Furthermore, findings show that cognitive processes, such as cognitive flexibility and working memory, are not facilitated by acute stress. Of particular relevance, working memory is related to emotion regulation, which is the intersection of emotional and cognitive processing. That is, working memory aids emotional regulation strategies, such as reappraisal and suppression, but working memory is negatively affected by stress, and that may, in turn, also negatively affect emotion regulation abilities. On the other hand, trait emotion regulation tendencies have been effective in regulating emotions and thus, trait emotion regulation may moderate the effect of stress on emotional experience and expression.

Chapter II - The functions of the acute stress response

The previous chapter argued that emotional processing, relative to cognitive processing, would lead to early onset of stimulus-driven behavioral responses. But why should early onset of stimulus-driven behavioral responses be adaptive during an acute stress response? As an answer this question, this chapter presents the argument that the early onset of stimulus-driven behavioral responses in an animal undergoing an acute stress response may first, help prevent disturbances to homeostasis and second, enable appropriate responses to trigger stimuli without time-consuming considerations of multiple behavioral responses. More specifically, this chapter argues that early onset of a behavioral response may facilitate an animal during acute stress by allowing the animal to initiate precautionary behavioral responses even before a disturbance occurs. Complementarily to early onset of behavioral responses, stimulus-driven processing may be adaptive during an acute stress response, because it may facilitate a reliable response which is appropriate for the stimulus in the situation by activating hardwired or learned stimulus-response links. This chapter starts with an introduction to the evolutionary psychology perspective, applies this perspective to the acute stress response, and elaborates the main arguments concerning early onset of stimulus-driven behavioral responses during an acute stress response.

A functional view of the acute stress response

Adaptive problems (e.g., digestion) required adaptive solutions (e.g., intestines; Tooby & Cosmides, 2005). Such solutions were created through genetic combinations corresponding to phenotypic features, including neural features and their corresponding behaviors, which were or were not adaptive for the problem at hand (Tooby & Cosmides, 2005). Natural selection refers to the process through which the adaptive genetic combinations, but not the maladaptive ones, propagated into future generations (Tooby & Cosmides, 2005). More specifically, the genetic combination which helped an organism to survive until reproduction would be carried on into future generations by the offspring of that organism, as well as by organisms which were more likely than others to carry the genes of that organism (i.e., kin who are not offspring; Tooby & Cosmides, 2005). In contrast, genetic combinations which did not help an organism to survive until reproduction would be less likely to be carried on into future generations, due to the death before reproduction of the organism carrying that combination (Tooby & Cosmides, 2005).

Through this mechanism of natural selection, the more adaptive genetic combinations become more prevalent in future populations, while less adaptive ones become less prevalent (Tooby & Cosmides, 2005).

An evolutionary psychological perspective applies the mechanisms of evolution, in particular, natural selection, to psychological and behavioral phenomena. One evolutionary psychological account states that certain behaviors, or more specifically, certain information-behavior links, are more adaptive than others (Tooby & Cosmides, 2005). To illustrate, while the behavior of running would not per se help an animal, running away at the sight of a stalking lion would increase its chances of survival (Tooby & Cosmides, 2005). Many examples of adaptive information-behavior links can be found in the animal literature. For example, when cats get frightened, their hair stands up and their backs arch (Marks & Nesse, 1994), serving to make them look bigger than they are; when squid get approached by a predator, they spray ink and escape (Marks & Nesse, 1994), making it difficult for the predator to follow them; and blood or injury cues can cause fainting (i.e., bradycardiac syncope), which may help reduce blood loss after injury and inhibit further attack by a predator (Marks, 1988). The existence of such specific information-behavior links seems to support the notion that certain responses (e.g., the arching of a cat's back) are more adaptive than others (e.g., grooming) for specific stimuli (e.g., a barking dog).

According to contemporary theories in evolutionary psychology (Nesse et al., 2007; Tooby & Cosmides, 2005), natural selection leads to adaptive psychological and behavioral mechanisms which are more or less domain-specific. Domain-specific processing systems have been hypothesized to be efficient in solving adaptive problems, because such systems are designed to process specific types of information (Tooby & Cosmides, 2005). For example, empirical findings have shown that psychological mechanisms, such as attention, are sensitive to the nature of the information being processed. More specifically, participants in a change detection paradigm were able to notice changes involving animals (human and non-human) in visual scenes better than they could notice changes involving inanimate objects, such as buildings and motor vehicles (New, Cosmides, & Tooby, 2007). This result was interpreted to mean that the attentional system may have a domain-specific subsystem designed to process information involving animals (New et al., 2007; Tooby & Cosmides, 2005). This sort of specificity has been demonstrated not only with attention, but also with memory, learning, and inferential systems (Tooby & Cosmides, 2005). This sensitivity to specific content is supposed to give an adaptive advantage to domain-specific, relative to domain-general, information processing architectures by allowing distinct inference rules to specific types of information, creating favored hypotheses, thereby reducing the time required for problem-solving, and by enabling an organism to "fill in the blanks" when perceptual information is not available (for a more detailed explanation, see Tooby & Cosmides, 2005; pp. 46-48).

While the contemporary theories of evolutionary psychology discussed above seem to agree that adaptive mechanisms are domain-specific, they also acknowledge some variance in the degree of domain-specificity among adaptive mechanisms. Taking the example of attention again, in some cases, attention can be focused on any task-relevant object in a visual scene, regardless of what kind of object it is (Tooby & Cosmides, 2005). This suggests that some less domain-specific mechanisms of attention do not take the type of information into account.

In the context of stress responses, both domain-specificity and domain-generality seem to be present to some extent. One example of domain-specificity would be the distinct behavioral responses comprising the fight-flight and tend-befriend behavioral stress responses (cf. Taylor et al., 2000). Large behavioral differences exist between these two patterns of responses to stress, with the fight-flight response being characterized by aggressive or fleeing behaviors; and the tend-befriend response being characterized by nurturing behaviors and the development of a social support system (Taylor et al., 2000). Unlike the behavioral responses however, the physiological mechanisms underlying the fight-flight and tend-befriend responses are more similar, and a common physiological mechanism (i.e., autonomic and HPA axis activation) seems to underlie both behavioral responses (Taylor et al., 2000; pp. 413, 415). Therefore, some aspects of stress responses, such as the physiological stress response, may be more general than others (Buss, 1995; Tooby & Cosmides, 2005), such as the behavioral responses comprising the fight-flight and tend-befriend stress responses.

The common physiological response underlying the fight-flight and tend-befriend responses is relatively general. Supporting this claim is the fact that some aspects of this response are common to all vertebrates (Nesse et al., 2007). More specifically, all vertebrates have the proopiomelanocortin molecule (POMC) and can produce corticosteroids, two important components of the autonomic nervous system (ANS) and HPA axis physiological stress response (Nesse et al., 2007). Therefore, these components of the acute stress response may underlie multiple distinct behavioral stress responses which are displayed by different vertebrates. Furthermore, it has been suggested that these components of the acute stress response have stayed stable for hundreds of millions of years, and that the reason for this stability is that the mechanism serves multiple functions (Nesse et al., 2007; p. 966). In sum, important mechanisms underlying multiple stress responses, may also be common mechanisms underlying the fight-flight and tend-befriend stress responses. The differences between the fight-flight and tend-befriend stress responses may arise from modifications to these general physiological mechanisms. For example, although the same general physiological mechanism underlies both acute stress responses, especially in females, oxytocin release is increased, leading to the behavioral patterns described by the tend-befriend stress response (Taylor et al., 2000).

To summarize, evolutionary psychological theory states that adaptive psychological and behavioral mechanisms are selected through natural selection and are more or less domain-specific (Tooby & Cosmides, 2005). There are varying degrees of specificity, and relatively general mechanisms, such as the physiological mechanisms underlying the fight-flight and tend-befriend stress responses (Taylor et al., 2000), may underlie multiple relatively specific mechanisms . This paper mainly focuses on the relatively general acute stress mechanisms (i.e., the physiological mechanisms).

Early onset of stimulus-driven behavioral responses: the function of the acute stress response

This subchapter presents two arguments, namely that the general physiological mechanisms underlying an acute stress response function to first, aid early onset of behavioral responses in response to stressors and second, to aid stimulus-driven behavioral responses in response to stressors. Moreover, this argument focuses on why early onset of stimulus-driven behavioral responses, facilitated by such mechanisms, would be adaptive during an acute stress response. In short, early onset of a behavioral response may help prevent a disturbance to homeostasis which may have occurred without the early initiation of the behavioral response. Furthermore, the stimulus-driven nature of the response may help ensure that the initiated response is appropriate for the eliciting stimulus. Such early onset of stimulus-driven behavioral responses may not always be adaptive, such as when one has enough time to logically consider the best option from multiple behavioral options. However, in the case of a stress response, where time is limited, and urgent behavioral responding is needed, early onset of stimulus-driven behavioral responses would be better than a time-consuming, logical consideration of multiple options.

As mentioned above, the first argument of this subchapter is that early onset of behavioral responses in response to cues of danger are adaptive. Previous literature has described the mechanisms of a stress response in the context of control systems (Nesse, 2005). In these descriptions, behavioral responses can be taken both before and after a disturbance has occurred. In the former case, an early onset of a behavioral response to a cue of potential danger, made possible through mechanisms such as classical conditioning, may help to prevent a disturbance. For example, once an animal has associated exposure to sunlight with a rise in body temperature, the animal may move into a cooler location upon exposure to sunlight, even before its body temperature actually rises (Nesse, 2005; p.91). In this case, the early onset[8] of moving to a cooler location, made possible through classical conditioning, helps the animal to prevent the disturbance of homeostasis associated with exposure to sunlight, namely an increase in body temperature. Similarly, running away upon hearing rustling noises can be adaptive for an impala, because it can help the impala to escape from a predator which may have made that noise before being caught by the predator (Nesse, 2005). Put together, early onset of behavioral responses may be useful for an animal during a stressful situation because such responses can help the animal to prevent disturbances ranging from relatively small ones, such as a rise in body temperature from exposure to sunlight, to relatively large ones, such as attack from a predator. As with behaviors which occur before the occurrence of a stress response, this paper assumes that responses to potential cues of danger should also occur early even after a stress response has been initiated, in order to prevent new disturbances which may occur as a result of the danger encountered after initiation of the stress response.

Interestingly, when viewed in terms of costs and benefits in a signal-detection context (Nesse, 2005), such early onset of defensive responses may be beneficial in the long-run, even if

[8] This type of defense should, however, be distinguished from a response which is carried out with greater speed. The early onset of the unconditioned or conditioned response is defined by an earlier onset of the response, rather than a faster speed with which the response is carried out.

many of the individual responses are false alarms (i.e., the response occurs to a non-threatening cue). To paraphrase an example (Nesse, 2005; p. 95), if the defensive response of running away at the sound of rustling leaves has a cost of 300 kilocalories and the cost of harm from the predator is 300,000 kcal, it would be worthwhile to engage in 999 false alarms in the long run, in order to avoid one actual attack. In other words, when the cost of a disturbance is greater than the cost of a defensive response, it may be worthwhile to engage in preventive behavioral responses even if they are false alarms, in order to eventually prevent an actual disturbance. Given the adaptive value of early onset of behavioral responses to cues of danger, processes which facilitate such early onset of behavioral responses may be enhanced by basic physiological mechanisms of an acute stress response.

This paper argues that while early onset of behavioral responses may help prevent disturbances from potential dangers, such early onset of responses may be facilitated by automatic, stimulus-driven responses. Put differently, early onset of a behavioral response and the stimulus-driven nature of that response are complementary in that early onset of the response can help to prevent a disturbance from occurring, and the stimulus-driven nature of the behavioral response can help ensure that the response taken is appropriate for the eliciting stimulus. Therefore, the early onset of the behavioral response can be adaptive in a temporal manner, but the stimulus-driven nature of the response can be adaptive in terms of determining the type of response taken. Stimulus-driven responses can help an animal to carry out responses which are appropriate for the specific stimuli in a situation. More specifically, unconditioned stimulus-response links such as the response of salivating upon perception of food (Pavlov, 2003), may not only enable early onset of responses, but also enable a response (e.g., salivation) which is appropriate for the specific stimulus (e.g., food) encountered. Therefore, stimulus-driven responses may facilitate early onset of appropriate responses, particularly for unconditioned stimuli (e.g., a rattlesnake).

The unconditioned stimulus-response links mentioned above, relative to conditioned stimulus-response links which are obtained through associative learning, may have been shaped by natural selection and seem to serve adaptive functions. As mentioned above, examples of such adaptive, unconditioned stimulus-response links include the arching of a cat’s back in response to a threatening object, spraying behavior of squid in response to a predator, and bradycardiac syncope (for a list of defensive responses to events and situations, see Nesse, 2005; p.93). Among learned stimulus-response links as well, the existence of learning biases (e.g., Mineka, Davidson, Cook, & Keir, 1984) suggests that certain stimulus-response links are more adaptive than others, and therefore are more easily learned. For example, rhesus monkeys are born without a fear of snakes, but after seeing another monkey get scared by a snake, rhesus monkeys learned to fear snakes although they did not exhibit the same learning pattern after seeing another monkey get scared by a flower (Mineka et al., 1984). In other words, although the fear response is not an unconditioned response to a snake in rhesus monkeys, it was nonetheless learned preferentially, relative to a fear response to flowers, through operant conditioning (Mineka et al., 1984). These findings seem to suggest that a learning bias exists for evolutionarily relevant stimuli such as snakes. Thus, stimulus-driven behavioral responses may be adaptive during a stress response not only because they occur early and are appropriate for the specific stimuli in a given situation, but also because they are responses which have been reliably adaptive through evolutionary time.

To summarize, this subchapter argues that the function of the physiological responses underlying an acute stress response is to facilitate mobilization for early onset of stimulus-driven behavioral responses. These characteristics may be adaptive during an acute stress response because first, early onset of behavioral responses may help prevent potential disturbances from occurring. Second, stimulus-driven behavioral responses help the animal to not only quickly generate a response, but also to generate a response which is appropriate for the stimulus at hand. The rationale for this argument is that stimuli can activate adaptive stimulus-response links which have developed through natural selection.

Chapter summary

This chapter discussed the evolutionary psychological view that information-behavior links have been selected through the process of natural selection, with adaptive information-behavior links being more or less domain-specific. The physiological mechanisms underlying the fight-flight and tend-befriend acute stress responses is claimed to be a relatively general stress response, whose functions include hastening the onset of and reducing the control of behavioral responses during an acute stress response. Early onset of behavioral responses to potentially threatening stimuli is hypothesized, in this paper, to be adaptive, because it can prevent a potential disturbance to homeostasis (e.g., such as when an animal moves into the shade upon exposure to sunlight, before body temperature rises). Stimulus-driven responses during an acute stress response are hypothesized to be adaptive in that they could quickly activate adaptive stimulus-response links which are appropriate for the specific stimuli in a given situation. The two adaptive functions are complementary in that the early onset of a response would only be adaptive if it is appropriate for the stimulus to which it is a response. Conversely, a stimulus-driven response may occur earlier than a response which is made after considering multiple possible responses. The next chapter discusses the psychological characteristics facilitating early onset of stimulus-driven behavioral responses.

Chapter III - Influence of emotional and cognitive processes on social decision-making outcomes

As argued in the previous chapter, the physiological mechanisms underlying an acute stress response may enhance emotional processing, but not cognitive processing (Metcalfe & Mischel, 1999). In turn, these two types of processing may influence decision-making behaviors differently, as dual-process theories of decision-making have stated (Loewenstein & O'Donoghue, 2004, 2007; Metcalfe & Mischel, 1999). Given the relationships between emotional and cognitive processing and decision-making behaviors, the current chapter examines the emotional and cognitive processes which influence behaviors in the Ultimatum Game, a social decision-making task. More specifically, this chapter describes the effects of emotion and emotion-regulation in the context of the Ultimatum Game and reviews findings which suggest that emotions and emotion regulation alter behaviors in the game.

Before reviewing the relationship between emotion, emotion regulation, and social decision-making, previous research which has examined the relationship between stress and social decision-making will be described. Previous research has examined the effect of psychosocial stress on social decision-making behaviors, with results suggesting that psychosocial stress increases prosocial decision-making between individuals (von Dawans et al., 2012; but see also Takahashi et al., 2007). To describe in more detail, employing tasks which measure prosocial behaviors and antisocial behaviors, the study found that psychosocial stress, relative to control, increases prosocial behaviors while not influencing antisocial behaviors (von Dawans et al., 2012).

The Ultimatum Game (Guth, Schmittberger, & Schwarze, 1982) is a decision-making task in which two players, a Proposer and a Responder, decide how to split a sum of money (e.g., 10 dollars) between the two people. The Proposer is given a fixed amount of money to split it with the Responder and is told to offer a portion of the money to the Responder, keeping the rest of the money for himself/herself. The Responder then has the choice to either accept the offer, resulting in both parties receiving the amount proposed by the Proposer; or to reject the offer, in which case both parties would receive no money.

According to the traditional assumptions of economic theory, the Responder, caring only about maximizing monetary utility, would be willing to accept any positive sum of money (Camerer, 2003). Knowing this, the Proposer would offer the least possible non-zero amount of money to the Responder. This prediction however, has been disconfirmed in many experiments (cf. Camerer, 2003). On average, Proposers offer $4 to $5 out of $10 to the Responder, and Responders reject about half of the offers of $2 or less (Camerer, 2003).

These empirical results are not explicable by theories which assume that decision-makers value only monetary rewards, but they can be explained by theories which incorporate non-monetary values, such as fairness (e.g., Rabin, 1993), into an individual's utility function. To elaborate the model of Rabin (1993), in a two-person interaction, each person's utility function is comprised not only of the monetary amount the person receives from the interaction, but also of the perceived kindness of the other person, as well as the kindness of oneself, directed towards the other person[9]. This model incorporates the concept of reciprocity, whereby perceived unkindness from one's interaction partner would result in a negative utility, and this negative utility would be minimized only if the person were to reciprocate the perceived unkindness with unkindness toward the interaction partner. On the other hand, if one perceives their partner to be kind, their utility from this perceived kindness would be positive, and this positive utility would

[9] Mathematically, this utility function is described with the following expression:

$$U_i(a_i, b_j, c_i) = \pi_i(a_i, b_j) + f_j(b_j, c_i) * [1 + f_i(a_i, b_j)]$$

Where U_i is the overall utility of person i. a_i is the strategy of person i, b_j is the strategy of person j, and c_i is the expectation of person i, regarding the strategy of person j.
$\pi_i(a_i, b_j)$ represents the monetary payoff for person i, given the strategies of both persons. $f_j(b_j, c_i)$ represents the fairness of person j, as perceived by person i. this terms takes into account the actual strategy of person j, and the expectation of person i, regarding person j's strategy. $f_i(a_i, b_j)$ is the fairness of person i towards person j, given the strategies of both i and j.
Both $f_j(b_j, c_i)$ and $f_i(a_i, b_j)$ range between -1 and +1/2. Thus, if $f_j(b_j, c_i)$ is negative (i.e., person j is perceived as being unfair), the overall utility of person i is reduced (i.e., disutility from perceived unfairness). In turn, since the lower limit of $f_i(a_i, b_j)$ is -1, and the term $1 + f_i(a_i, b_j)$ cannot be negative, the overall utility would be maximized When the term $1 + f_i(a_i, b_j)$ is zero, thereby neutralizing any disutility from perceived unkindness. Thus, in case person i perceives person j's activity to be unfair, person i would maximize their utility by being unfair in return to person j.
Conversely, if $f_j(b_j, c_i)$ is positive, the overall utility of person i would be maximized if $f_i(a_i, b_j)$ is also positive (specifically, +1/2), whereas person i's overall utility would be diminished if $f_i(a_i, b_j)$ were negative.

be maximized by returning a kind behavior, as opposed to an unkind behavior (see footnote 10 for a detailed mathematical description). Through this mechanism, Rabin's model incorporates reciprocity, based on perceived kindness or unkindness, into an individual's utility function[10].

Putting the concept of disutility into measurable psychological terms, Pillutla and Murnighan (Pillutla & Murnighan, 1996) propose that hurt pride and anger lead to spiteful behaviors. More specifically, they describe a mechanism whereby perceived unfairness creates a sense of hurt pride in the receiver of unfairness and anger, which may lead to a reciprocal act of unfairness toward the interaction partner, namely rejecting the unfair offer(Pillutla & Murnighan, 1996; p. 211). Within this framework, hurt pride and anger may be seen as the disutility[11] from perceived unkindness, and this disutility could be neutralized by a reciprocal act of unkindness, or a rejection of an unfair offer.

This model was tested in an Ultimatum Game experiment in which Proposers made offers of $1 or $2 to Responders who had the choice of accepting the offer, rejecting the offer, or taking an outside option (Pillutla & Murnighan, 1996). Perceived fairness was experimentally varied by informing or not informing Responders about the total sum of money ($20, $4, or $2) being divided by the Proposer (Information), as well as informing or not informing the Responder whether the Proposer knew of their outside option or not (Common knowledge). Furthermore, participants wrote down how they felt after each offer, providing self-reports of perceived fairness as well as anger. Results showed that Responders who knew how much total was being divided (i.e., complete information) saw more offers as being unfair than those who did not know (i.e., partial information), and that anger was increased when Responders knew that the Proposer knew of their outside options (i.e., common knowledge), compared to when they did not know (i.e., no common knowledge). Importantly, a combination of complete information and common knowledge led to more rejections than any other condition, suggesting that a combination of perceived unfairness and anger lead to rejections of Ultimatum Game offers. These results seem to support the argument that a sense of hurt pride from unfair treatment leads

[10] In the context of an Ultimatum Game, overall utility in Rabin's (1993) model may not be maximized through reciprocal behavior, as reciprocal behavior on the part of the Responder would reduce $\pi_i(a_i, b_j)$, or the utility from monetary payoff to zero.
[11] Although not mentioned in Pillutla and Murnighan (1996), utility from perceived kindness may be operationalized as gratitude or joy, leading to reciprocal acts of kindness.

to anger, which leads to inefficient negotiations (Pilluta & Murnighan, 1996) and furthermore seem consistent with Rabin's (1993) argument that perceived unfairness creates disutility which can be alleviated through reciprocal behaviors.

In sum, rejections in the Ultimatum Game cannot be explained with theories assuming that individuals gain utility only from monetary rewards. The rejections can be explained by theories which incorporate social preferences such as fairness into the individual's utility function (Rabin, 1993). The concept of disutility from unfairness (Rabin, 1993) can be operationalized in terms of emotions such as anger (Pillutla & Murnighan, 1996) and experimental results have confirmed that perceived unfairness leads to a negative emotion (i.e., anger), which then increases rejections of offers perceived to be unfair (Pillutla & Murnighan, 1996). These emotions, in turn, can be regulated by cognitively modulated emotion-regulation strategies such as reappraisal and suppression. Therefore, in the context of an Ultimatum Game, negative emotions should be positively associated with rejections of unfair offers, whereas emotion regulation should be negatively associated with rejections of such offers. The remainder of this section describes the empirical support for these claims.

Effect of emotion on Ultimatum Game decisions

Empirical support for the hypothesis that negative emotions increase rejections of unfair offers comes from studies which have measured emotional responses to the unfair offers (i.e., integral emotions; Pham, 2007; Rick & Loewenstein, 2007) as well as studies which have induced emotional states irrelevant to the Ultimatum Game offers (i.e., incidental emotions; Pham, 20007; Rick & Loewenstein, 2007). For example, rejections of unfair offers are reduced when participants are given another method for expressing negative emotions (Xiao & Houser, 2005). More specifically, when participants were given a chance to write a message to their partner after a one-shot Ultimatum Game, they expressed their emotions (79% of Responders who received an offer of 20% or lower wrote a message expressing a negative emotion) through the written message. Importantly, participants in this emotion expression group rejected fewer unfair offers, relative to a no-emotion-expression group. Based on these results, the authors suggested that rejections of unfair offers may be an expression of negative emotions when no direct method of expression (in their case, a written message) is available (Xiao & Houser, 2005; p. 7401). Brain imaging studies have further illustrated the role of emotions in social decision making. For example, amygdala activity, which is associated with emotions (Hamann & Mao, 2002), was correlated with rejections in the Ultimatum Game (Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). These findings support the claim that negative emotions are positively associated with Ultimatum Game rejections[12].

Even incidental emotions, or emotions which are not directly associated with the decision-making task, have been shown to influence behaviors in the Ultimatum Game (e.g., Harle & Sanfey, 2007, 2010; Moretti & di Pellegrino, 2010), suggesting that emotions per se, and not only those which are induced by unfair offers, influence Ultimatum Game behaviors[13]. Within the framework of fairness theories, this could be construed as 'disutility' (or 'utility') from factors other than perceived unfairness (or fairness) as influencing Ultimatum Game behaviors. While the studies in the previous paragraph focused on emotions induced by the partner's offer during the game, the studies described below examined the effects of emotions induced by stimuli which were irrelevant to the game, such as movie clips (amusement and sadness; Harle & Sanfey, 2007), pictures (sadness and disgust; Moretti & Pellegrino, 2010), and negative social evaluations (Fabiansson & Denson, 2012). For example, experimentally induced positive (i.e., amusement) and negative emotions (i.e., sadness) influenced rejection rates in a subsequent Ultimatum Game. Specifically, results showed higher rejections in the sadness than in the amusement condition, suggesting that emotional valence influences Ultimatum Game rejections, specifically with negative valence increasing rejections of unfair offers. These findings further support the claim that emotions, particularly negative emotions, influence decisions in the Ultimatum game by showing that the experience of emotions per se influences their behaviors in the game. Together, the above suggest that emotions, especially negative emotions, both those which are induced by unfair offers, as well as those which exist independently of the Ultimatum Game, influence Responders' rejections of unfair offers.

[12] Negative emotions influence behaviors in other experiments, in similar ways. For example, in a public good game with costly punishment, participants assigned costly punishment with no current or future monetary benefit to group members who contributed little to a resource pool (Fehr & Gaechter, 2002). Importantly, in hypothetical scenarios, participants also reported more negative emotions, namely anger and annoyance, toward a member of their group who contributed significantly less than the other members of the group. Given these findings, the authors suggested that emotions are a mechanism underlying costly punishments in public good games.

[13] This seems to be a different mechanism than the one described by Rabin (1993) or Pillutla and Murnighan (1996).

Finally, it should be noted that these effects of negative emotions may not necessarily play a harmful role, at least in terms of monetary gain, in social decision-making studies. For example, the anticipation of emotional responses from a partner, whether monetary or non-monetary, seem to induce more fair behaviors from players in the public good game (e.g., Fehr & Gaechter, 2002) and from givers in the Dictator game (Ellingsen & Johannesson, 2008; Xiao & Houser, 2009). These findings suggest that although in certain situations, such as in one-shot games, negative emotions may lead to reduced monetary gains (as they can increase rejection rates), in other situations where a rejection of an unfair offer can prompt more fair behaviors in the future, negative emotions may eventually lead to increased monetary gains. Moreover, depending on the nature of one's utility function (i.e., whether it includes only monetary utility or other social factors), the expression of negative emotions may increase or decrease one's utility in general.

In conclusion, emotions have been shown to influence Ultimatum Game decisions (e.g., Sanfey et al., 2003). Negative emotions have been particularly well-studied, and have been shown to increase rejections of unfair offers (Pillutla & Murnighan, 1996). Furthermore, emotions may not necessarily be adaptive or maladaptive for efficient decision-making, rather interacting with the specific situations in which the decisions are being made. These findings lend support to the argument (e.g., Sanfey et al., 2003) that emotions, not only those experienced in response to perceived unfairness, but also incidental emotions which are not related to the decision-making task, underlie rejections of unfair offers in the Ultimatum Game.

Effect of emotion regulation on Ultimatum Game decisions

Compared with the literature on the effect of negative emotions on Ultimatum Game behaviors, there is less empirical support for the hypothesis that emotion regulation strategies which reduce the 'disutility' from perceived unfairness decrease rejections of unfair offers. Nonetheless, emotion regulation strategies have been associated with lower rejection rates in the Ultimatum Game. For example, general emotion regulation abilities have been associated with decisions in the game (Koenigs & Tranel, 2007), with damage to the ventromedial prefrontal cortex (vmPFC), a brain region linked with emotion regulation (Burgess and Wood, 1990), being associated with higher rejections of unfair offers in the Ultimatum Game (van't Wout, Chang, &

Sanfey, 2010). The use of emotion regulation strategies[14] may result in milder behavioral responses to unfair offers by decreasing the experience of negative emotions associated with such offers. For example, distraction was effective in reducing rejections, compared with affective rumination (Wang et al., 2011). More specifically, during a time delay after getting anger-inducing offers (i.e., $2 out of $10) in the Ultimatum Game, Responders who were asked to "start writing numbers, starting at 1… until the next page appears" rejected less than those who engaged in affective rumination during the time delay (Wang et al., 2011). In another study, participants in an Ultimatum Game who were instructed to engage in reappraisal of Ultimatum Game offers, rejected fewer unfair offers, compared to participants in the control and suppression conditions (van't Wout et al., 2010). Together, these findings support the hypothesis that the use of certain (although not all) emotion regulation strategies can reduce rejections of unfair offers in the Ultimatum Game.

Emotion-regulation strategies vary in terms of their effects on behaviors, however, and not all strategies may lead to reduced rejections of unfair offers. Specifically, reappraisal is associated with lower experience of negative emotions, whereas suppression is associated with higher experience but lower expression of negative emotions (Gross & John 2003). Thus, not all emotion-regulation strategies may decrease Ultimatum Game rejections. Indeed, empirical findings regarding suppression suggest that, unlike reappraisal, it does not reduce the rejection of unfair offers. More specifically, participants who were asked to suppress their emotions during an Ultimatum Game showed no difference in terms of rejection rates, compared to a control group (van't Wout et al., 2010). Given the varying effects of specific emotion regulation strategies on Ultimatum Game decisions, the present research examined two well-studied strategies, namely reappraisal and suppression, with differing effects on Ultimatum Game behaviors.

In conclusion, emotion regulation strategies may influence Ultimatum Game rejections by controlling the experience and expression of the emotions associated with unfair offers. Reappraisal may reduce rejections of unfair offers by reducing the negative emotions experienced in response to such offers. Furthermore, although theoretically, suppression may

[14] For example, one may rationalize the unfairness by telling oneself that unfairness is a normal part of life which cannot be avoided (Pillutla & Murnighan, 1996).

reduce rejections by reducing the expression of negative emotions experienced by the person, previous empirical findings suggest that suppression is at least not as effective as reappraisal in reducing rejections of unfair offers.

Chapter summary

Models of social decision-making which incorporate social preferences can explain rejections of unfair offers through constructs such as reciprocity (Rabin, 1993). Reciprocity, the returning of kindness for kindness and unkindness for unkindness (Rabin, 1993), has been proposed to be one mechanism underlying rejections of unfair offers in the Ultimatum Game (e.g., Pillutla & Murnighan, 1996). Many experimental studies have provided empirical support for the claim that reciprocity plays an important role in social decision-making (e.g., Knoch, Pascual-Leone, Meyer, Treyer, & Fehr, 2006). Moreover, emotions, particularly negative emotions, have been shown to be a crucial component of reciprocal behaviors (e.g., Xiao & Houser, 2005). More specifically, negative emotions, both integral (Xiao & Houser, 2005) and incidental (Harley & Sanfey, 2007), have been shown to increase rejections of unfair offers. Furthermore, emotion regulation strategies, such as reappraisal, have been shown to be effective in reducing rejections of unfair offers (van't Wout et al., 2010), perhaps by modulating the negative emotional responses to those offers.

Introduction summary

Based on previous predictions (Metcalfe & Mischel, 1999), the present paper posits that processing of emotional aspects of stimuli is associated with the ability to engage in early and stimulus-driven responses. Therefore, as previously suggested (Metcalfe & Mischel, 1999), enhancement of emotional processing may facilitate early onset of stimulus-driven behavioral responses during an acute stress response. Cognitive processing may not be enhanced during an acute stress response however, since it occurs later than and is more controlled than emotional processing (Barrett et al., 2007; Metcalfe & Mischel, 1999; Murphy & Zajonc, 1993; Zajonc, 1980, 1984). Empirical findings provide general support for the notion that stress enhances both processing of emotional stimuli after encountering the stressor (e.g., Luethi et al., 2008), and that stress intensifies emotional experience (Wang et al., 2005). On the other hand, cognitive processing such as working memory and cognitive flexibility seem not to be enhanced (e.g., Alexander et al., 2007).

Furthermore, based on previous arguments (Metcalfe & Mischel, 1999), this paper presents two reasons that early onset of stimulus-driven behaviors should be adaptive during an acute stress response. Specifically, early onset of a behavioral response to a stressor may help prevent a disturbance from that stressor, and a stimulus-driven response may facilitate the selection of appropriate responses for eliciting stimuli.

Putting this into the context of a social decision-making task, specifically in the context of the Ultimatum Game, an enhancement of emotional processing may intensify the negative emotions felt in response to unfair offers, and thereby lead to higher rejections of such offers. However, emotion regulation may counteract the influence of negative emotions on decisions to some degree (e.g., van't Wout et al., 2010). Given these arguments, the current research aimed to examine whether acute stress would increase rejections of unfair Ultimatum Game offers, whether this effect would be mediated by increased negative emotions, and whether the effect of negative emotions on rejections would be moderated by trait emotion regulation tendencies.

Chapter IV – Experiments

Overview of studies

As mentioned earlier, there is a burgeoning literature on the effects of acute stress on social decision-making (cf. van den Bos et al., 2013), but this literature does not seem to yet examine mediating and moderating factors of the link between stress and social decision-making. One main aim and contribution of this research is to address this gap by examining the mediating and moderating roles, respectively, of emotions and emotion regulation tendencies. Generally, acute stress is expected to increase emotional processing, but not cognitive processing. In particular, acute stress has been shown to be associated with, and to increase emotional reactions to subsequent stimuli (e.g., Petzold et al., 2010) and experience of negative emotions (e.g., Wang et al., 2005); whereas it reduces working memory capacity (Schoofs et al., 2009), a cognitive modulator of the regulation of emotion (Schmeichel et al., 2008). Based on previous findings (e.g., van't Wout et al., 2010; Xiao & Houser, 2005), emotion and emotion-regulation are in turn, expected to affect social decision-making behaviors, namely in the Ultimatum Game. More specifically, negative emotions, which have been shown to both be influenced by stress (e.g., Wang et al., 2005) and to increase rejections of unfair offers (e.g., Xiao & Houser, 2005), may mediate the effect of acute stress on Ultimatum Game rejections. On the other hand, trait emotion-regulation tendencies such as the tendency to employ cognitive reappraisal, have been shown to effectively regulate negative emotions (e.g., Gross & John, 2003), and may moderate the relationship between acute stress and rejections of unfair offers.

While previous studies have examined the effects of psychosocial stress on social decision-making, the current study employed a physical stress induction procedure which has been shown to have different effects from physical stress in animal studies (Pacak, 2000). Specifically, the present research employed the Cold Pressor Test (CPT; Bullinger et al., 1984), which requires participants to leave their hand in either ice water (experimental condition) or warm water (control condition) for up to three minutes. After completing the stress manipulation, participants completed the Ultimatum Game (Guth et al., 1982), a decision-making task in which a Proposer offers a portion of 10 Euros to the Responder. To recapitulate, the Responder can choose to accept the offer, resulting in both parties receiving the amount proposed by the

Proposer; or to reject the offer, in which case both parties would receive no money. In both of the studies presented here, all participants played in the role of Responder.

Given that stress increases emotional reactivity, increasing negative emotions in particular (Sinha et al., 2008; Wang et al., 2005), individuals under stress may experience and express more negative emotions than those not under stress. The emotion-decision link is related to stress in that Ultimatum Game rejections are positively associated with negative emotions, whether or not they are relevant to the Ultimatum Game (e.g., Harle & Sanfey, 2007; Sanfey et al., 2003; Xiao & Houser, 2005). Therefore, stressed participants, experiencing more negative emotions in response to unfair offers (but not fair offers), than non-stressed participants, may reject more unfair offers in the Ultimatum Game than participants in the control condition. This rationale leads to the first hypothesis:

- Participants in the stress condition would reject more unfair offers, but not fair offers, relative to participants in the control condition (H1).

Based on the findings discussed above, stress was expected to increase negative emotions. This hypothesis was tested in Study 1, using explicit measures of both specific emotions and general negative-positive valence. Given the theoretical and empirical background discussed in previous chapters, negative emotions were expected to be associated with higher rejection rates of unfair offers. This second set of hypotheses is summarized below:

- Based on previous findings relating negative emotions to stress, negative emotions were expected to be higher in the stress condition than in the control condition (H2a).
- Negative emotions were expected to be associated with higher rejections of unfair offers (H2b).

Hypotheses 1, 2a, and 2b comprise the mediation hypothesis that acute stress would increase rejections of unfair offers, mediated by negative emotions.

Trait emotion regulation tendencies have been associated with emotional experience and expression (Gross & John, 2003). Specifically, reappraisal, reinterpreting the meaning of a situation, is associated with less experience and expression of negative emotions, whereas suppression, not showing how one feels, is associated with less expression, but not experience of negative emotions (Gross & John, 2003). So it may be that reappraisal may help reduce the experience of negative emotions even in the stress condition, thereby leading to high reappraisers being less affected by stress in terms of negative emotions than low appraisers. On the other hand, suppression may not help to reduce the experience of negative emotions, and there may not be a difference between high and low suppressors in terms of negative emotions in the stress or control groups. Therefore, reappraisal may moderate the effect of stress on rejection rates by reducing the negative emotions experienced in both the stress and control conditions, whereas suppression may moderate the effect of stress on rejection rates, not by reducing the experience of negative emotions, but by reducing the expression of negative emotions. This argument leads to the third set of hypotheses:

- The effect of stress on rejection rates is expected to be moderated by trait emotion regulation tendencies. Specifically, among the stressed participants, but not among control participants, low re-appraisers and low suppressors, collectively referred to as low emotion regulators, are expected to reject more unfair offers than high emotion regulators (H3a).

Interestingly, although re-appraisal and suppression may have similar moderating effects on the stress-rejections link, they may affect the underlying emotions differently. More specifically, compared with high re-appraisers, low re-appraisers may reject more unfair offers because they experience more negative emotions. On the other hand, low suppressors, relative to high suppressors, may reject more unfair offers because low-suppressors cannot suppress the expression of their negative emotions. High suppressors, although they are able to suppress their negative emotions, may experience the same amount of negative emotions as low suppressors, whereas high re-appraisers should experience and express less negative emotions than low re-appraisers (Gross, 1998). This leads to the following additional hypotheses:

- High reappraisers should experience less negative emotions than low appraisers, particularly in the stress condition (H3b).

- High and low suppressors in either the stress or control conditions should not differ in terms of experience of negative emotions (H3c).

Hypotheses 3a-3c comprise the moderation hypotheses regarding emotion regulation.

A different possibility from the above hypotheses should be noted however. Specifically, while trait emotion regulation may help reduce negative emotions under stress, stress may also reduce emotion regulation abilities, due to its negative influence on working memory. This reduction of emotion regulation abilities would in turn, increase the experience and expression of negative emotions in the context of the Ultimatum Game (i.e., rejection of unfair offers). More specifically, even individuals with high reappraisal tendencies may feel negative emotions in response to unfair offers, and thus show no difference from the low reappraisers in negative emotions or rejections. Similarly, individuals low in suppression tendencies may be less likely to suppress during a stress response, compared to individuals high in suppression or non-stressed individuals.

Last but not least, because an early onset of behavioral response is thought to be crucial under acute stress, participants under stress are hypothesized to show faster reaction times than those who are not stressed. This is stated in the following hypothesis.

- Stressed participants will show faster decision times than non-stressed participants (H4).

Experiment 1

Methods

In order to test the hypotheses above, the first experiment employed a 2 (stress: stress vs. control) x 2 (amount: fair vs. unfair) design, with stress being a between-subject and amount being a within-subject factor. Self-report ratings of state emotions and a trait emotion regulation measure were employed.

<u>Participants</u>

Fifty-four participants (34 females) took part in the experiment for payment or course credit. In addition, they received money earned from the experiment. There were 29 participants in the stress (18 females) and 25 in the control condition (16 females). The average age of participants was 25.07 (*SD*=6.28; range=18-42). Participants did not have a history of heart disease (including coronary artery disease, angina, or arrhythmia), peripheral vascular disease, diabetes, Reynaud's phenomenon, cryoglobulinemia, vasculitis, or lupus. All were non-smokers who were not currently taking hormone birth control or any other hormone replacement medications, and not taking corticosteroid medications or beta-adrenergic agonists. Participants were told to avoid eating, drinking (except water), or sleeping within 2 hours of the study, and to avoid exercising within 1 hour of the experiment.

Tasks and Measures

Scales and Questionnaires

The Faces Pain Scale (FPS; Bieri, Reeve, Champion, Addicoat, & Ziegler, 1990) and Visual Analog Scale (VAS; Carlsson, 1983) were used to measure the amount of pain participants experienced before and during the stress (or control) task. The FPS (Bieri et al., 1990) consists of six faces, starting with a neutral expression, indicating no pain, and the sixth face expressing and indicating extreme pain. Participants were asked to point to the face which corresponded to either their level of pain at the time of measurement (before the stress or control task) or the highest pain level felt during the stress or control task. The VAS (Carlsson, 1983) consists of a horizontal line, with the left end indicating “No Pain” and the right end indicating “Worst Possible Pain”. Participants were asked to mark with an ‘X’ the level of pain they felt, before and during the peak of the stress or control task. Participants completed the scales immediately before and after the stress or control task.

Participants were asked to report 10 state emotions, including anger, pride, happiness, sadness, shame, excitement, pleasant relaxation, nervousness, anxiety, and boredom on a five-point Likert scale (*1-not at all, 5-extremely*).

A modified version of the Affect Grid (Russell, Weiss, & Mendelson, 1989) was used to measure state emotions in terms of negative or positive valence and low or high arousal. The Affect Grid in the present study consisted of a 9 x 9 grid, with the left indicating “Extremely Positive” valence and the right indicating “Extremely Negative” valence. The top indicated high arousal (i.e., “Extremely Aroused”) and the bottom indicated low arousal (i.e., “Extremely Inactive”).

The Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) was used to measure participants’ tendency to reappraise and suppress their emotions. The 10-item scale contains two subscales assessing reappraisal and suppression tendencies and assesses the tendency to reappraise or suppress positive and negative emotions. The reappraisal subscale included six items (e.g., “When I want to feel more *positive* emotion (such as joy or amusement), I *change what I’m thinking about.*”) and the suppression subscale included four items (e.g., “I control my emotions by *not expressing* them.”). The items were rated on a 7-point Likert scale (*1-strongly disagree, 7-strongly agree*).

Cold Pressor Test

The Cold Pressor Test (Bullinger et al., 1984; Mather, Lighthall, Nga, &Gorlick, 2010) was used as a stress induction method and saliva samples were collected for cortisol data. Participants submerged their non-dominant hand up to their wrist in cold (0.6-3 degrees Celsius; *M*=1.60, *SD*=.72) or warm (37-40 degrees Celsius; *M*=38.11, *SD*=.87) water, respectively, for 1-4 minutes (*M*=2.33,*SD*=.90). In order to intensify the stress response, participants were told that they would do the CPT in the same condition 30 minutes after doing it the first time (Mather et al., 2010), but in fact, participants underwent the CPT only once.

Cortisol Assessment

Saliva samples were collected by drooling into a tube before the CPT (Time 1), 15 minutes after the CPT (or 5 minutes before the UG; Time 2), and 30 minutes after (Time 3) the CPT (Buchanan, Tranel, & Adolphs, 2006; Lighthall et al., 2009). Participants drank an eight ounce cup of plain water at least ten minutes before providing their first saliva sample in order to ensure clean samples. For each saliva sample, participants gathered at least 1mL of saliva in total (Mather et al., 2010) by drooling through a straw into two plastic tubes (Innovation Beyond Limits). Each tube was labeled and stored at -30 degrees Celsius (Lighthall et al., 2009) after collection and shipped via ground transport to the IBL analysis center.

Ultimatum Game

The design of the Ultimatum Game followed a within-subject format similar to designs used in previous research (e.g., Moretti & Pellegrino, 2010; Sanfey et al., 2003). Participants played 24 rounds of the Ultimatum Game and were informed that they would interact with people in different locations to split 10 Euros in each trial. Participants were informed that 10%

of their earnings would be paid at the end of the experiment. The experimenter then asked participants to play a computer lottery to decide whether they would play the game as a Responder or a Proposer. In fact, all participants were assigned to the Responder role and the role remained the same throughout the experiment.

The Ultimatum Game had six trials each with 50% (5 out of 10 Euros), 30% (3 out of 10 Euros), 20% (2 out of 10 Euros), and 10% (1 out of 10 Euros) offers. In order to prevent participants from strategically rejecting offers in order to get higher offers in future rounds, participants were informed that they would not interact with a particular Proposer more than once. Participants did not know the total number of rounds in the Ultimatum Game.

At the beginning of each trial, participants saw question marks on the screen, representing potential partners, and chose a partner by clicking on a question mark. For each trial, participants saw a picture of their partner (i.e., the Proposer) while waiting for the partner to make their offer. Half of the Proposers for each offer amount were female, and the other half were male, and Proposers' pictures were presented in a different random order for each participant. The duration of the waiting period was variable, ranging between 5-10 seconds. After the waiting period, the offer made by the Proposer (e.g., "You get 3€. He gets 7€.") was presented for 1 second. Then, the computer asked for a decision ("Accept or reject?"). Participants were given up to 10 seconds to make their decision and forfeited the offer if they took longer. Participants pressed one of two keys to indicate either an accept or a reject response. Following the response, the outcome of their decision was presented (e.g., "You accepted the offer. You get 3€. He gets 7€.") and stayed on the screen until participants pressed a key to continue to the next trial. Before participants started the task, they played two practice trials to ensure that they understood the procedures and rules of the game. Stimuli were presented using EPrime 2.0 software (Psychology Software Tools, Pittsburgh, PA), and faces of Proposers were taken from the FACES database (Ebner, Riediger, &Lindenberger, 2010).

Procedure

Upon arrival, participants drank an eight ounce cup of water and gave their first saliva sample (Time 1) at least 10 minutes (*M*=21.94, *SD*=6.29) after drinking the water. Participants provided informed consent, and filled out the Emotion Regulation Questionnaire (ERQ; Gross &

John, 2003) as well as several additional personality questionnaires. Approximately 10 minutes (*M*=8.21, *SD*=4.94) after the first (i.e., baseline) saliva sample, participants completed the CPT. Participants gave pain ratings (Cahill, Gorski, & Le, 2003; Smeets, Otgaar, Candel, & Wolf, 2008) using the Faces Pain Scale(FPS; Bieri et al., 1990) and Visual Analogue Scale (VAS; Carlsson, 1983) immediately before and after the CPT. Participants read UG instructions and neutral reading materials for 15 minutes (Buchanan et al., 2008; Lighthall et al., 2009) after completing the CPT. Participants then provided their second saliva sample approximately 15 minutes (*M* = 14.44, *SD*=2.29) after the CPT (Time 2). The second saliva sample collection was followed by the UG, which started about 20 minutes (*M*=20.19, *SD*=3.26) after the CPT. Before and after the UG, participants completed ratings for 10 discrete state emotions (i.e., anger, pride, happiness, sadness, shame, excitement, pleasant relaxation, nervousness, anxiety, and boredom) on a five-point Likert scale (*1-not at all, 5-extremely*) as well as the Affect Grid (Russell et al., 1989). After the UG (approximately 30 minutes after the CPT; *M*=30.66, *SD*=4.30) participants provided their third saliva sample (Time 3) and completed demographics as well as other questionnaires. The experiment was conducted between 12pm and 6pm.

Results

Data from one participant, whose reaction times on the decision-making task were 2 SDs higher than average, was removed. Reaction time outliers were calculated by averaging all reaction times for each individual (yielding 54 mean scores in total), obtaining the standard deviation of these 54 scores, and finding mean scores which were 2 SDs higher or lower than the average of the 54 scores. Trials in which participants took longer than 10 seconds to make their decision were treated as missing data. For the dependent variable, the rejection rates for the 5 Euro trials were treated as a baseline, and two dependent variables were created. First, the average of 1 and 2 Euro rejection rates was subtracted from the 5 Euro rejection rate, and second, the 3 Euro rejection rate was subtracted from the 5 Euro rejection rate in order to obtain rejection rates for unfair and fair offers, respectively. The former dependent variable is referred to as rejections of “unfair” offers and the latter dependent variable is referred to as rejections of “fair” offers. The use of this dependent variable is similar to previous studies which have grouped 10-30% offers as “fair” and 40-50% offers as “unfair” offers (Harley & Sanfey, 2007, 2010). Although 30% offers are still unfair, previous papers have grouped 10-20% offers as the offers which are rejected most frequently (60% in Xiao & Houser, 2005; about 50% in Camerer, 2003). Thus, in the present research, 30% and 50% offers were considered to be fair, relative to 10-20% offers.

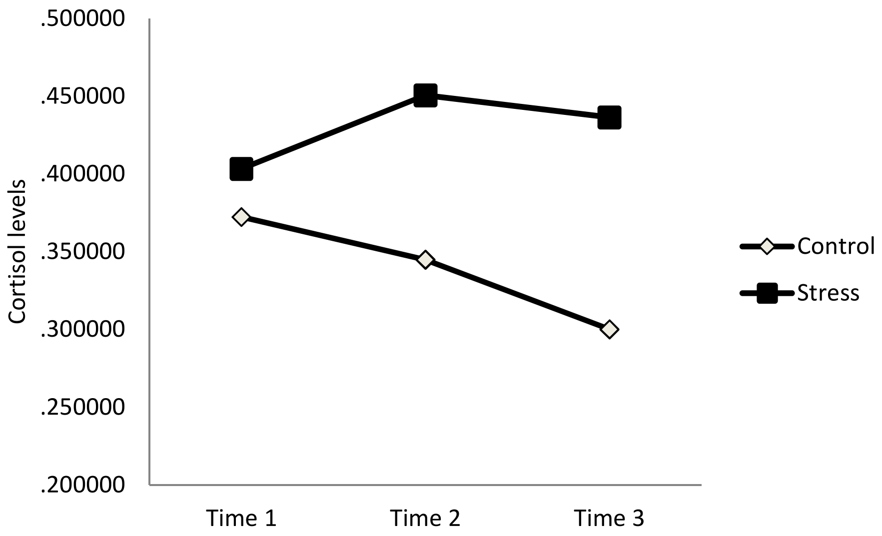
Manipulation checks

To check whether the CPT was successful in inducing pain and an acute stress response, pain ratings and cortisol levels of stress and control conditions were compared. A one-way (stress: stress vs. control) analysis of variance (ANOVA) on ratings of peak pain during the CPT, averaged across participants, yielded a significant difference between the stress (VAS: M=56.32, SD=26.10; FPS: M=3.91, SD=1.32) condition, and control (VAS:M=1.61, SD=2.64; FPS:M=1.04, SD=.20) condition, VAS: $F(1,53)=109.37$, $p<.001$; FPS: $F(1,53)=115.678$, $p<.001$.

A 3 (Time: 1, 2, vs 3) x 2 (Stress: stress vs. control) mixed model ANOVA on cortisol levels revealed a significant Time x Stress interaction, $F(2,102)=3.17$, $p<.05$, $\eta^2=.06$, (see Figure 1). Specifically, post-hoc analyses of covariance (ANCOVAs) with baseline cortisol level as a covariate revealed that stressed participants had significantly higher cortisol levels, compared to control participants, at both Time 2 (stressed: M=.45, SD=.22, control: M=.34, SD=.18), $F(1,53)=4.33$, $p<.05$, $\eta^2=.08$, as well as Time 3(stressed: M=.44, SD=.26, control: M=.30, SD=.15), $F(1,53)=5.26$, $p<.05$, $\eta^2=.10$. There was no main effect of time on cortisol levels, $F(2,102)<1$.

These results indicate that participants in the stress, relative to control, condition experienced more peak pain during the stress task. Moreover, controlling for baseline cortisol levels, participants in the stress, relative to control, condition showed higher levels of cortisol at 15 and 30 minutes after the stress task.

Figure 1. Cortisol levels at three time intervals (before, 15 minutes after, and 30 minutes after the stress/control task) in Experiment 1.



<u>Behavioral Results</u>

Next, the hypothesis that stress, compared to control, would increase rejections of unfair offers (H1) was tested. Additionally, since sex differences in acute stress response have been reported in previous research (Lighthall et al., 2013; Wang et al., 2007), sex was entered as an additional factor. Means and standard deviations (*SD*s) for rejection rates are presented in Table 1.

A 2 (amount: fair vs. unfair) x 2 (stress: stress vs. control) x 2 (sex: male vs. female) mixed model ANOVA on rejection rates revealed a significant main effect of offer amount on rejection rates, $F(1, 49)=75.51$, $p<.001$. The Amount x Stress interaction for rejection rates was also significant, $F(1,49)=4.22$, $p<.05$, $\eta^2=.08$. Mean scores of rejection rates showed a statistically non-significant trend for higher rejection of unfair offers in the stress condition (M=81.96%, SD=26.01%) than in the control condition (M=68.67%, SD=35.62%). Nonetheless, the difference between stress and control conditions for rejections of unfair offers did not reach statistical significance (p=.12). Therefore, the first hypothesis was partially confirmed in that, as shown by the significant Amount x Stress interaction, stress had an effect on rejections of unfair, relative to fair, offers.

The results reported above were not significantly modulated by sex. Specifically, neither the Stress x Amount x Sex interaction (p=.60) nor the Sex x Amount interaction were significant (p=.06). These results indicate that stress interacted with the fairness of offers, with mean rejection rates indicating the expected direction, but not statistically significant, with stressed participants showing higher rejections of unfair offers than non-stressed participants.

Figure 2. Mean rejection rates as a function of stress and offer amounts in Experiment 1.

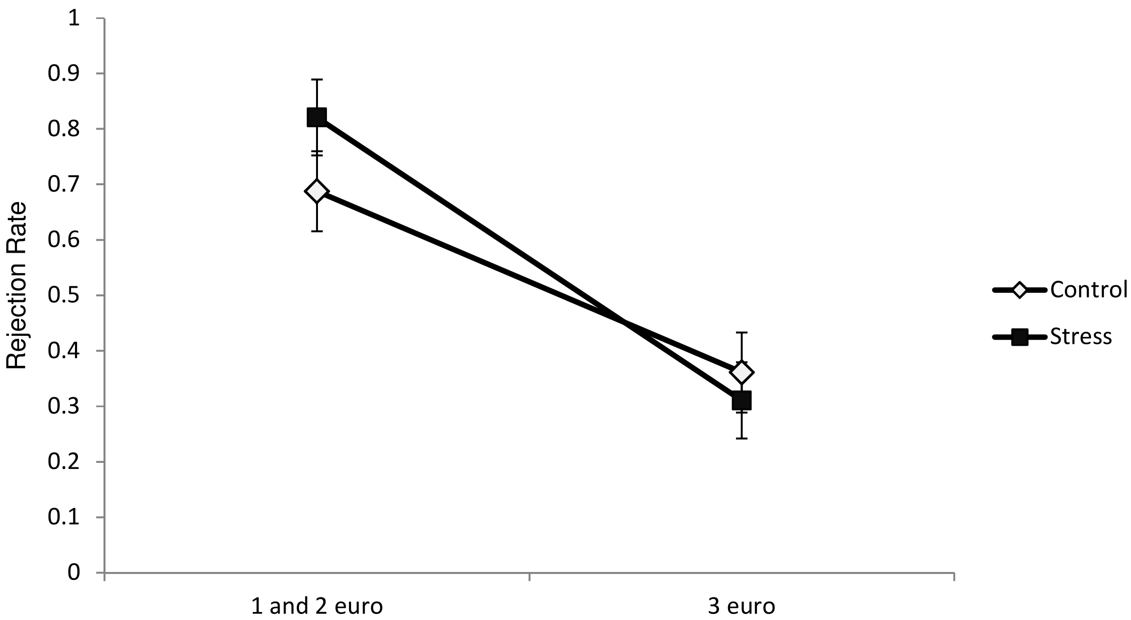


Table 1. Mean rejection rates as a function of stress and offer amounts in Experiment 1.

	Control		Stress	
	M	*SD*	*M*	*SD*
Rejections of unfair offers	0.69	0.36	0.82	0.26
Rejections of fair offers	0.36	0.40	0.31	0.38

Emotion ratings

Means and SDs for emotion ratings are presented in Table 2. Two measures of negative emotions were calculated. The first measure of negative emotions was calculated by subtracting the pre-UG valence scores of the Affect Grid from the post-UG valence scores of the Affect Grid. The second measure of negative emotions was calculated by taking the post-pre-UG difference of each of the 10 discrete emotions, and calculating the average of the difference scores of the six negative emotions (i.e., sadness, anger, boredom, anxiety, nervousness, and shame). The analyses for H2a and H2b were conducted using the valence difference score from the Affect Grid as well as the average difference scores of the six negative emotions.

Table 2. Means and standard deviations for emotion ratings in stress and control conditions in Experiment 1.

	Control		Stress	
	M	*SD*	*M*	*SD*
Negative emotion change	0.00	0.38	-0.06	0.29
Positive emotion change	-0.13	0.35	-0.13	0.49
Valence change	-0.07	1.80	-0.49	1.89
Arousal change	-0.04	0.38	0.40	1.68

To test the first hypothesis in the second set of hypotheses (H2a), one-way ANOVAs (stress: stress vs. control) were conducted on difference scores calculated by subtracting negative emotions before the Ultimatum Game from negative emotions after the Ultimatum Game (negative emotion change). This analysis showed no differences between stress and control groups for any of the dependent variables, *p*s>.2. This result indicates that participants in the stress, relative to control, condition did not significantly differ in the pre-post change in self-reported negative emotions. Furthermore, ANOVAs on the difference scores of positive emotions (positive change) showed no differences between stress and control conditions.

To test the second hypothesis in the second set (H2b), negative emotion change scores were correlated with rejection rates of unfair offers. Unexpectedly, negative emotions were not correlated with rejections of unfair offers, *p*>.15. To examine whether this null effect was due to differences between stress conditions, a partial correlation was conducted, with stress condition as a controlling variable. The results again showed no significant correlation between negative emotion change and rejections of unfair offers, $p>.2$.

Since previous research has shown effects of acute stress on discrete emotions, supplementary analyses were conducted, testing for effects of stress on self-reported emotions (see Table 3 for means and standard deviations). Univariate ANOVAs revealed no significant differences between stressed and non-stressed participants in any of the 10 emotions for pre-post-UG difference scores, $ps>.1$. Additionally, a one-way ANOVA (stress: stress vs control) on pre-post UG difference scores of arousal (Affect Grid) showed no significant difference between stress and control conditions, $F<1$, $p>.4$.

Table 3. Means and standard deviations for ratings of 10 discrete emotions in stress and control conditions in Experiment 1.

	Control		Stress	
	M	*SD*	*M*	*SD*
Pleasant relaxation	0.00	1.00	0.15	0.80
Excitement	-0.52	1.23	-0.26	0.64
Happiness	-0.12	0.83	-0.40	0.83
Pride	-0.08	0.81	0.00	0.67
Shame	-0.12	0.67	-0.07	0.38
Boredom	-0.08	0.64	-0.18	0.55
Nervousness	-0.40	0.58	-0.41	0.73
Sadness	0.16	0.80	0.00	0.39
Anger	0.16	1.31	0.62	0.91
Anxiety	-0.20	0.58	-0.29	0.46

Trait emotion regulation

Before conducting analyses to test the third set of hypotheses, the average scores for overall emotion regulation[15] as well as each type of emotion regulation were calculated for all 53 participants, and high and low regulators were defined as those with scores above and below the average (*M*=4.45 for overall, *M*=4.80 for reappraisal, *M*=3.93 for suppression), respectively. There were 28 high emotion regulators (16 in stress condition), 25 low emotion regulators (12 in stress condition), 10 high reappraisers (7 in stress condition), 43 low reappraisers (21 in stress condition), 29 high suppressors (12 in stress condition) and 24 low suppressors (16 in stress condition).

To test H3a, a 2 (amount: fair vs unfair) x 2 (stress: stress vs control) x 2 (emotion regulation: high vs low) mixed model ANOVA was conducted on rejection rates. No significant interaction effects on rejection rates were found between Amount x Stress x Emotion regulation, $p>.4$, Amount x Stress, $p>.05$, or Amount x Emotion regulation, $p>.1$. Additional analyses revealed no significant interactions when Reappraisal and Suppression were entered separately. More specifically, a 2 (amount: fair vs unfair) x 2 (stress: stress vs control) x 2 (reappraisal: high vs low) ANOVA and a 2 (amount: fair vs unfair) x 2 (stress: stress vs control) x 2 (suppression: high vs low) ANOVA revealed no significant interactions, *p*s>.05.

Only high reappraisers were expected to differ in terms of negative emotions. Specifically, they were expected to show less negative emotions than low reappraisers, particularly in the stress, relative to control, condition (H3b). First, a 2 (stress: stress vs. control) x 2 (reappraisal: high vs. low) ANOVA on negative emotion change revealed no significant Stress x Reappraisal interaction, $F(1,53)<1$. Next, as a test of H3c, a 2 (stress: stress vs. control) x 2 (suppression: high vs. low) ANOVA on negative emotions was conducted (see Table 4). Unexpectedly, this analysis showed a significant Stress x Suppression interaction, $F(1,53)=7.64$, $p<.01$. Post-hoc ANOVAs showed that among control participants, low suppressors showed a significantly *smaller* increase in negative emotions (*M*=-.24, *SD*=.42) than high suppressors (*M*=.08, *SD*=.26), $F(1,25)=5.06$, $p<.05$. In contrast, among stressed participants, low suppressors showed a *greater* increase in negative emotions (*M*=.04, *SD*=.20) than high suppressors (*M*=.24, *SD*=.42), which did not reach statistical significance, $F(1,28)=2.45$, $p>.1$.

[15] For this factor, the average of all 10 emotion regulation items (six reappraisal items and four suppression items) was calculated.

Table 4. Pre-post Ultimatum Game change in negative emotions by stress and suppression groups in Experiment 1.

	Control				Stress			
	Low Suppress		High Suppress		Low Suppress		High Suppress	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Negative emotion change	-0.25	0.43	0.08	0.26	0.03	0.21	-0.13	0.32

Additional analyses were conducted, to examine whether overall emotion regulation tendencies influence rejections of offers. Specifically, a 2 (emotion regulation: high vs. low) x 2 (amount: fair vs. unfair) mixed-model ANOVA was conducted on rejection rates. Results showed a marginally significant Emotion Regulation x Amount interaction, $F(1,51)=2.95$, $p=.09$. Interestingly, post-hoc tests revealed no difference between high and low emotion regulators for unfair offers, $F(1,53)<1$, but revealed a significant difference between high emotion regulators (n=28) and low emotion regulators (n=25) for 3 Euro offers, $F(1,53)=4.64$, $p<.05$, with high regulators rejecting less (M=45.33%, SD=40.12%) than low regulators (M=23.21%, SD=34.65%).

Reaction Times

To test the hypothesis that stressed participants, relative to non-stressed participants, will display faster reaction times in their decisions, a one-way ANOVA (stress: stress vs. control) was conducted on average reaction times, collapsed across trials. A marginally significant effect of stress was found, $F(1,53)=3.56$, $p=.07$. The mean scores indicated, however, that the stressed participants were slower to make their decisions (M=2327.70 msec, SD=554.60 msec) than control participants (M=1995.34 msec, SD=724.78). Therefore, the fourth hypothesis could not be confirmed, although an unexpected result was nonetheless found.

Discussion

Experiment 1 tested the hypothesis that acute stress response would increase rejection rates in an Ultimatum Game. This hypothesis was based on the argument that acute stress, enhances emotional processing, especially increasing the experience of negative emotions. This effect of acute stress on negative emotions, would in turn, lead to an increase in rejections of unfair, but not fair, Ultimatum Game offers. Furthermore, this effect would be moderated by emotion-regulation strategies, namely reappraisal and suppression. Therefore, after confirming that the stress manipulation effectively induced a stress response, mediation and moderation analyses were conducted in Experiment 1.

Pain ratings confirmed that participants experienced more peak pain during the stress, relative to control, task. More importantly, cortisol levels at 15 and 30 minutes after the CPT, controlling for baseline levels, were higher in stressed participants than in non-stressed participants. These results confirm that the CPT stress induction was successful in inducing an acute stress response. The next analyses showed that, as in previous studies, the offer amount had a highly significant effect on rejection rates. More interestingly, in a test of the central hypothesis of Study 1, a significant Amount x Stress interaction was found. Nonetheless, the post-hoc tests of the effect of stress on unfair offers, perhaps due to insufficient statistical power, did not show a statistically significant difference between stress and control groups. Therefore, the first hypothesis (H1) was only partially confirmed, with stress, relative to control, influencing rejection rates .

In contrast to expectations, negative emotions, measured as the difference between post and pre-UG negative emotions, were not increased by acute stress, nor did they correlate with rejections of unfair offers. These results do not confirm the second set of hypotheses that stress increases negative emotions (H2a) and that negative emotions increase rejections of unfair offers (H2b). Thus, the mediation hypothesis was not confirmed.

The third set of hypotheses, namely that trait emotion regulation would moderate the stress-rejection link, was tested. First, the results showed that none of the measures of emotion regulation (i.e., overall emotion regulation, reappraisal, suppression) interacted with stress and offer amount to affect rejection rates. Therefore, emotion regulation did not moderate the relationship between stress and rejection rates, failing to confirm H3a. Furthermore, neither H3b nor H3c could be confirmed. First, the hypothesis that high reappraisal would lead to lower negative emotions, particularly in the stressed participants (H3b), could not be confirmed, as high and low reappraisers showed no difference in self-reported negative emotions. In contrast with reappraisal, trait suppression did interact with stress condition, such that under stress, low suppressors, relative to high suppressors, showed a greater increase in negative emotions from pre to post UG, whereas the opposite was true in the control condition. This result nonetheless fails to confirm the hypothesis that suppression would not interact with stress to influence negative emotions (H3c).

Several unexpected but interesting results also emerged. First, although emotion regulation did not influence rejections of unfair offers, high regulators did reject less fair offers than low regulators. This may mean that while trait emotion regulation does not modulate rejections of offers to the degree of reducing unfair offers, it does modulate rejections of offers that are typically seen to be fair, although they are not perfectly fair (i.e., 50/50 split). In other words, trait emotion regulation may not be strong enough to reduce rejections of unfair offers, but it can reduce rejections of offers which are relatively fair. Second, although suppression was expected to not influence self-reported negative emotions, suppression interacted with stress such that in the control, but not stress condition, high suppressors showed greater negative emotions than low suppressors. This result seems consistent with previous findings showing that suppression is associated with greater experience of negative emotion (Gross & John, 2003). Finally, a marginally significant effect of stress on reaction times indicated that, contrary to expectations, stressed participants made slower decisions than control participants.

In sum, the main hypothesis concerning stress and rejection rates could be partially confirmed. More specifically, a significant Amount x Stress interaction was found, with mean scores going in the expected direction. The mediation hypothesis could not be confirmed, however, as there was no effect of stress on negative affect and no correlation between negative emotion and rejection rates. Similarly, the moderation hypothesis was not confirmed, with no expected interactive effects between amount, stress, and emotion regulation on rejection rates or negative emotions.

Experiment 2

Experiment 1 tested the hypothesis that acute stress response would increase rejections of unfair Ultimatum Game offers. This hypothesis was partially confirmed through a significant Amount x Stress interaction, with stress, compared to control, affecting rejection rates. One aim of the present experiment was to replicate the findings of the first study, in particular, the Amount x Stress interaction. Moreover, Experiment 2 tried to address a null finding in the previous experiment concerning negative emotions. More specifically, the main hypothesis of the previous experiment was based on the rationale that acute stress response would increase the activation of emotional states, which would in turn increase rejections of unfair offers. However, stress did not show an effect on explicit emotion ratings, failing to confirm the mediation hypothesis. Therefore, the present experiment took a different approach and experimentally manipulated the level of emotional experience by adding partner type as a third factor to the design of Experiment 1.

The rationale for adding the partner type factor stems from empirical findings suggesting that the partner type influences the degree of emotional reactivity that Responders experience in response to unfair offers (Knoch et al., 2006; Sanfey et al., 2003). For example, participants who received unfair offers from a computer, relative to a human, partner accepted more unfair offers and perceived the unfair offers to be less unfair than participants in the human partner condition (Knoch et al., 2006). Furthermore, the activity of the bilateral anterior insula, which was correlated with rejection decisions for unfair offers, was higher for unfair offers from human, relative to computer, partners (Sanfey et al., 2003). These findings suggest that rejections of unfair offers are increased, as well as associated brain activity, when unfair offers are given by a human, relative to a computer, partner. Given these findings, when an unfair offer is made by a computer, rather than a person, the negative emotions from the unfair offer may be reduced.

If the stress-rejection link disappears with a manipulation designed to reduce those negative emotions, it would be strong support for the hypothesis that the stress-rejection link is mediated by negative emotions. That is, if the stress-rejection link is mediated by negative emotions, and getting an unfair offer from a computer instead of a human reduces negative emotions, rejection rates should not increase even in the stress condition, as long as the partner is a computer. This manipulation provides a different method for testing the mediation hypothesis, since the results of the first study did not support this hypothesis. In other words, although explicit measures of negative emotions did not show a mediation relationship between stress, negative emotions, and rejections of unfair offers, this experimental manipulation could reveal a mediation relationship between the three variables. This approach differs from entering negative emotion scores as mediating factor for the stress-rejection link, in two ways. First, this is an experimental manipulation of negative emotions, whereas the covariate approach is correlational.

Second, while the influence of partner type on negative emotions may be explicit as well, partner type may also influence implicit negative emotions, which may lead to increased rejections of unfair offers.

In order to test the hypothesis regarding partner type, Experiment 2 employed a 2 (amount: fair vs. unfair) x 2 (stress: stress vs. control) x 2 (partner: human vs. computer) design. As discussed above, if the stress-rejection link is mediated by negative emotions, rejections of unfair offers should increase in the stress, relative to the control, condition only when the offers are perceived as coming from a human, rather than a computer. Therefore, the first hypothesis for Study 2 was formulated as below:

- In the computer-partner condition, no differences will be shown between stress and control conditions in terms of rejection rates (H5a).
- On the other hand, in the human-partner condition, stressed participants should reject more unfair offers than control participants (H5b).

Since negative emotions were supposed to mediate the relationship between stress and negative emotions, the hypotheses concerning rejections are as follows:

- In the computer-partner condition, no differences will be shown between stress and control conditions in terms of negative emotions (H6a).
- In the human-partner condition, stress will increase negative emotions in comparison to the control group (H6b).

As in Experiment 1, measures of state emotion and trait emotion regulation were included to test the mediation and moderation hypotheses, respectively. Due to the failure to confirm the mediation and moderation hypotheses in Experiment 1, however, an implicit measure of emotion was added in Experiment 2. The emotional go/no-go task (Wessa et al., 2007; Schulz et al., 2007) was used as a measure of implicit emotion. The emotional go/no-go task is designed to measure a participant's ability to inhibit a response to neutral and emotional stimuli (i.e., neutral and emotional faces; Schulz et al., 2007). More specifically, participants are presented with go and no-go stimuli, the former to which they produce a response (i.e., a button press) and the latter to which they produce no response. Since there are more go trials than no-go trials, the go trials are supposed to create a prepotent tendency to produce a response, and on the no-go trials, this response tendency must be inhibited (Schulz et al., 2007). Errors on no-go trials (i.e., pressing the button on a no-go trial), called commission errors, have been used as measures of behavioral inhibition, and reaction times on go trials as measures of behavioral execution (Schulz et al., 2007). Additionally, different measures of trait emotion regulation (described in detail later) were used.

In addition to emotions, Experiment 2 examined the relationship between stress and trait as well as state impulsivity. A previous study has shown a relationship between trait impulsivity and cumulative stress (Fox, Bergquist, Gu, & Sinha, 2010), suggesting that chronic stress may be related to trait impulsivity. Since chronic and acute stress may have different relationships with trait impulsivity, trait impulsivity was explored without a priori hypotheses. Furthermore, state impulsivity was measured as another exploratory factor.

Methods

Participants

Sixty-eight participants (41 females) participated in the experiment for payment or course credit in addition to money earned from the experiment. The average age of participants was 25.56 (SD=7.71, range=18-51). There were 40 participants in the human partner condition (21 stress, 24 female) and 28 participants in the computer partner condition (14 stress, 17 female). Inclusion criteria were the same as in Experiment 1. The CPT was conducted in the same way as in Experiment 1, except that saliva samples were not collected. In the stress condition, for both human and computer partner conditions, participants submerged their non-dominant hand up to their wrist in cold (0.9-3 degrees Celsius; M=2.22, SD=.68) water for 1-3 minutes (M=1.34, SD=.68). In the no-stress condition, participants submerged their non-dominant hand in warm (37-40 degrees Celsius; M=38.60, SD=1.07) water for 1-3 minutes (M=2.68, SD=.64). The UG started about 20 minutes (M=21.94, SD=7.11) after withdrawal from water.

Measures

Trait impulsivity was measured with the Impulsiveness and Venturesomeness subscales of the I_7 Impulsiveness Questionnaire (Eysenck, Pearson, Easting, & Allsopp, 1985) after it was translated to German. The Impulsiveness subscale contains 19 items (e.g., "Do you generally do and say things without stopping to think?") and the Venturesomeness subscale contains 16 items (e.g., "Do you quite enjoy taking risks?"). Items are rated with either a "Yes" or "No".

The State Impulsivity Questionnaire (STIMP; Wingrove & Bond, 1997) was used to assess state impulsivity. The questionnaire contains 14 items (e.g., "I behave spontaneously") and are rated on a four-point Likert scale (*1-not at all, 4-very*).

The emotional go/no-go task was a shortened and modified version of a procedure used in previous research (Schulz et al., 2007). The task included two blocks with 60 trials each (42 (70%) go trials, 18 (30%) no-go trials), with no-go trials randomly intermixed among go trials. In one block, emotional faces were go stimuli and neutral faces were no-go stimuli, and in the other block, neutral faces were go, and emotional faces were no-go stimuli. The order of presentation of the blocks was counterbalanced across participants. The stimuli were pictures of faces (six male, six female) expressing either fear (emotional) or emotional neutrality (neutral). Four of the six male (female) faces were shown in five trials each, and two of the six male (female) faces were shown in two trials each. Each block started with instructions concerning which stimulus to produce the response to. Participants were instructed to respond as quickly as possible to go stimuli. At the start of each trial, a fixation cross was presented at the center of the computer screen for 2000 msec. Next, the go (or no-go) stimulus was presented on the screen for 500 msec. In trials where participants gave a response within the 500 msec, the stimulus disappeared from the screen, but the fixation cross for the next trial nonetheless occurred after the whole 500 msec.

The Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) was used to measure trait emotion regulation, instead of the ERQ (Gross & John, 2003). Three of the six subscales of DERS were used. Specifically, participants rated on a five-point Likert scale (*1-almost never, 5-almost always*) the 5-item Goals subscale (e.g., "When I'm upset, I have difficulty getting work done."), designed to measure the ability to engage in goal-directed behavior when experiencing negative emotions; the 6-item Impulse subscale (e.g., "When I'm upset, I have difficulty controlling my behaviors."), designed to measure the ability to refrain from impulsive behavior when experiencing negative emotions; and the 8-item Strategies subscale (e.g., “When I’m upset, I believe that wallowing in it is all I can do.”), designed to measure access to emotion regulation strategies when experiencing negative emotions.

Procedure

The procedure for Experiment 2 was similar to that of Experiment 1 with three main differences. First, saliva samples were not collected. Second, in addition to the 10 state emotions, participants completed the State Impulsivity Questionnaire. Third, an implicit measure of negative emotion, the emotional go-no/go task, was used to measure implicit emotions after the Ultimatum Game. Besides these changes, the procedures for the human partner condition were identical to Experiment 1.

Participants played 24 rounds of the Ultimatum Game as the Responder. The CPT and Ultimatum Game designs were identical to that in Experiment 1, except for the following changes. Participants completed state impulsivity ratings in addition to emotion ratings 15 minutes after the CPT, shortly before starting the Ultimatum Game. In the computer partner condition, the instructions emphasized that each offer made by the computer was random and independent of the participant’s decisions. Thus, rejecting or accepting a particular offer amount would not affect the computer’s future offers. Similarly, participants in the human partner condition were explicitly informed that their decisions would not influence future offers. For each trial, in the computer partner condition, participants saw a computer and two die, rather than a person’s face, while waiting for the computer to make the offer. After completing the Ultimatum Game and providing explicit emotion ratings, participants completed the emotional go/no-go task.

Results

Reaction time outliers, data from time-out trials, and the dependent variables were calculated and treated identically to Experiment 1. Data from three reaction time outliers were excluded.

Manipulation checks

To check whether the CPT was a successful method of pain induction, pain ratings of the stress and control conditions were compared. A one-way ANOVA (stress: stress vs control) on ratings of peak pain, averaged across participants, during the CPT yielded a significant difference between the stress (VAS: *M*=45.36, *SD*=20.42; FPS: *M*=3.03, *SD*=1.02) condition, and control (VAS: *M*=4.13, *SD*=9.82; FPS: *M*=1.22, *SD*=.42) condition, VAS: $F(1,65)=106.62$, $p<.001$; FPS: $F(1,65)=87.38$, $p<.001$. These results indicate that the CPT successfully induced pain in the stress, relative to control, condition.

Rejection rates in the UG

Means and SDs for rejection rates are presented in Table 5. In order to replicate the interaction from the first experiment and to test the hypothesis that no effect of stress should be found in the computer-partner condition, a 2 (amount: fair vs. unfair) x 2 (partner: human vs. computer) x 2 (stress: stress vs. control) x 2 (sex: female vs. male) ANOVA was conducted on rejection rates. This analysis revealed a significant main effect of offer amount on rejection rates, $F(1, 57)=50.07$, $p<.001$. No Amount x Stress interaction was found, $F<1$, and the Experiment 1 result could not be replicated. All other interactions, except for two, were also not significant, *F*s<1. The two exceptions included a significant Amount x Partner interaction, $F(1,57)=6.60$, $p<.05$, and a significant Amount x Partner x Sex interaction, $F(1,57)=4.49$, $p<.05$. These interactions are explored in more detail (see below).

Although the results of Experiment 1 were not replicated, H5a and H5b were nonetheless tested by conducting two 2 (amount: fair vs. unfair) x 2 (stress: stress vs. control) x 2 (sex: female vs. male) ANOVA, one for each partner type condition. These analyses revealed no interaction or main effects (human: $p>.15$; computer: $p>.05$), except for the highly significant main effect of offer amount on rejection rates (human: $F(1,34)=52.58$, $p<.001$; computer: $F(1,23)=9.59$, $p<.01$).

Overall, the results regarding rejection rates from the first experiment could not be replicated, and the first hypothesis of Experiment 2 could not be confirmed by the results.

Table 5. Mean rejection rates in Experiment 2 as a function of stress condition and partner type.

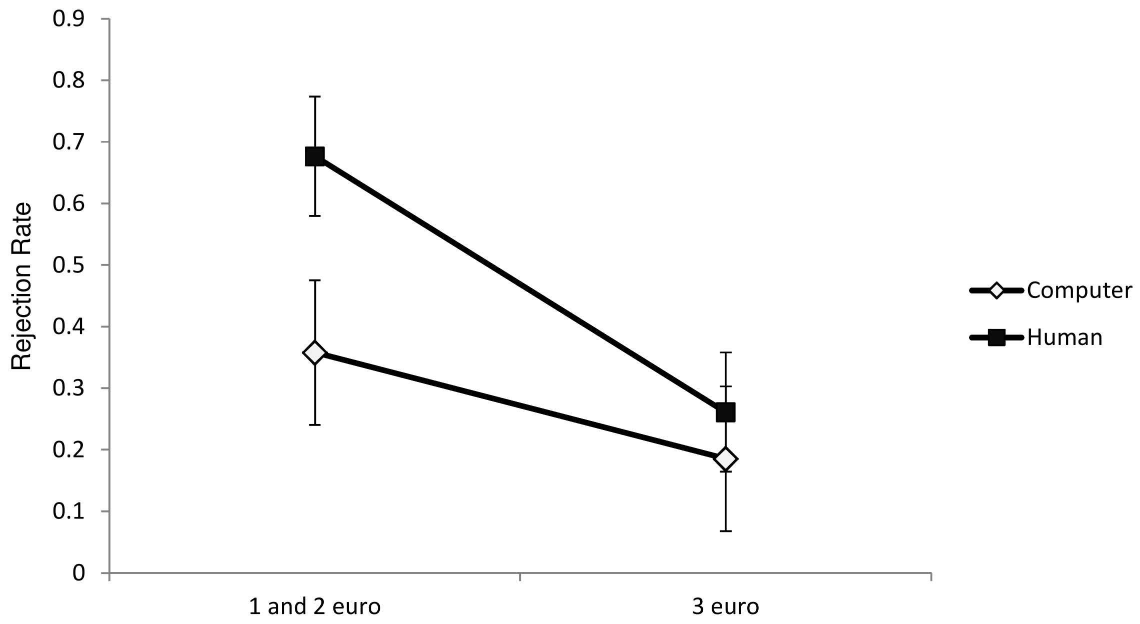
	Control				Stress			
	Computer		Human		Computer		Human	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Rejections of unfair offers	0.32	0.37	0.66	0.34	0.39	0.37	0.65	0.43
Rejections of fair offers	0.10	0.27	0.31	0.35	0.21	0.33	0.27	0.45

Additional analyses concerning Partner type

Due to the significant offer x partner interaction found in the initial analysis of rejection rates, separate analyses for the two partner conditions were conducted for rejections. First, a 2 (amount: fair vs. unfair) x 2 (partner type: human vs. computer) ANOVA on rejections confirmed the significant interaction effect, $F(1,63)=4.27$, $p<.05$ (see Figure 3). Separate analyses revealed that in both the human-partner and computer-partner conditions, participants rejected unfair offers more than fair offers. However, separate analyses of fair and unfair offers revealed that participants rejected significantly more unfair offers in the human-partner condition (M=65.61%, SD=35.12%) than in the computer-partner (M=35.12%, SD=36.81%) condition, $F(1,65)=10.17$, $p<.01$; whereas no significant differences were found between human and computer conditions for fair offers, $p>.1$.

The effect of partner on negative emotions was also explored with a one-way ANOVA on negative emotion change with partner (human vs. computer) as the factor. Results showed no difference between the human and computer partner groups, $F(1,65)<2$, $p>.2$.

Figure 3. Mean rejection rates as a function of partner type and offer amounts in Experiment 2.



<u>Emotion ratings</u>

Means and SDs for emotion ratings are presented in Table 6. To test hypotheses H6a and H6b, two sets of one-way (stress: stress vs. control) ANOVAs were conducted on the pre-post-UG differences in negative emotions (negative emotion change)[16], one on the human, and one on the computer condition. The results showed no significant interactive or main effects of the two factors on negative emotion, $Fs<1$. Furthermore, a 2 (stress: stress vs. control) x 2 (partner: human vs. computer) ANOVA across partner types showed that the Stress x Partner interaction was non-significant, Fs<1. No differences in negative emotion changes were found between stress and control groups nor for human and computer partner groups, $p>.2$. These results show that as in Experiment 1, stress did not significantly influence explicit ratings of negative emotions. Furthermore, partner type did not significantly influence explicit negative emotions.

[16] The two measures of negative emotions included pre-post UG difference scores of valence of the Affect Grid and the average of the difference scores of the six negative emotions (i.e., sadness, anger, boredom, anxiety, nervousness, and shame) in the 10-item discrete emotion scale.

Table 6. Means and standard deviations for explicit emotion ratings by condition in Experiment 2.

	Control				Stress			
	Computer		Human		Computer		Human	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Negative emotion change	0.05	0.26	-0.12	0.51	0.01	0.31	-0.08	0.43
Positive emotion change	-0.25	0.49	-0.4	0.51	-0.27	0.72	-0.29	0.59
Valence change	-0.29	1.44	-0.67	1.19	-0.62	2.57	-0.25	1.33
Arousal change	-0.36	1.15	1.00	1.37	-0.15	1.34	0.50	1.50

Additional analyses were conducted to examine whether negative emotion change[17] was correlated with rejection rates of unfair offers. A marginally significant correlation between change in negative emotions and rejections of unfair offers was found, $r(65)=2.40$, $p=.05$. Furthermore, a marginally significant positive correlation was found between change in negative emotions and rejections of fair offers, $r(65)=.22$, $p=.08$, as well as a marginally significant negative correlation between change in positive emotions and rejections of unfair offers, $r(65)=-.23$, $p=.07$. As in Experiment 1, partial correlations were conducted between negative emotion change and rejections of unfair offers, with stress condition as a controlling variable. The results showed the same pattern as those from the bivariate correlation analyses above. When partner condition was also controlled for, significant correlations emerged between unfair offer rejections and negative emotion change, $r(61)=.33$, $p<.01$, and fair offer rejections and negative emotion change, $r(61)=.26$, $p<.05$. The correlation between unfair offer rejections and positive emotion change remained marginally significant as well, $r(61)=-.22$, $p=.09$. Finally, Arousal change was greater in the human partner ($M=.74$, $SD=1.45$) condition than in the computer partner ($M=-0.26$, $SD=1.23$) condition, F(1,63)=8.47, p<.01. These results show that when the factors of stress and partner type are controlled, rejections of unfair as well as fair offers are significantly correlated with change in negative emotion.

Since previous research has shown effects of acute stress on discrete emotions, supplementary analyses were conducted, testing for effects of stress on each discrete self-reported emotion. Table 7 shows the means and standard deviations for the 10 discrete emotion ratings. Univariate ANOVAs revealed no significant differences between stress and control conditions in terms of pre-post-UG difference scores of nine of the 10 emotions, *p*s>.1. The exception was that stressed participants reported marginally lower change in pride ($M=-0.09$, $SD=.77$) than control ($M=-0.47$, $SD=.84$) participants, $F(1,65)=3.59$, $p=.06$. Univariate ANOVAs revealed no significant differences between computer-partner and human-partner participants in terms of pre-post-UG difference scores of nine of the 10 emotions, *ps*>.1. The exception was that human-partner participants reported a decrease in boredom from before to after the UG ($M=-.26$, $SD=1.00$) whereas computer-partner participants reported an increase in boredom ($M=.22$, $SD=.70$), $F(1,65)=4.68$, $p<.05$.

[17] These results are for the average of the six negative emotions from the 10-item discrete emotion scale. No significant correlations were found When using the valence difference scores.

Table 7. Means and standard deviations for ratings of 10 discrete emotions by condition in Experiment 2.

	Control				Stress			
	Computer		Human		Computer		Human	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Happiness	-0.07	0.62	-0.06	0.80	-0.08	1.32	-0.55	0.83
Anger	0.21	0.58	0.44	1.38	0.38	0.77	0.45	1.10
Pride	-0.14	0.66	-0.72	0.89	-0.23	0.83	0.00	0.73
Anxiety	-0.14	0.36	-0.39	0.78	-0.15	0.38	-0.15	0.59
Shame	0.14	0.36	-0.11	0.58	0.15	0.80	-0.10	0.72
Excitement	-0.64	1.01	-0.22	0.88	-0.46	1.05	-0.45	1.28
Sadness	-0.07	0.73	0.00	1.19	-0.08	0.49	0.10	0.79
Nervousness	-0.14	0.77	-0.50	0.51	-0.38	0.77	-0.40	0.75
Pleasant relaxation	-0.14	0.95	-0.61	0.78	-0.31	1.11	-0.15	1.18
Boredom	0.29	0.73	-0.17	0.99	0.15	0.69	-0.35	1.04

To test the hypotheses concerning the effects of stress on implicit measures of negative emotions (H6a and H6b), 2 (stress: stress vs control) x 2 (partner: human vs computer) ANOVAs were conducted on six dependent variables from the emotional go/no-go task, including commission errors (i.e., making the button press on a no-go trial) from fear-nogo and calm-nogo blocks, omission errors (i.e., not making the button press on a go trial) from fear-go and calm-go blocks, and reaction times to go trials in fear-go and calm-go blocks. Means and SDs for these dependent variables are shown in Table 8. No significant Stress x Partner interaction effects were found, *Fs*<2, *ps*>.2, failing to confirm the hypotheses that partner type would moderate the relationship between stress and negative emotions. Nonetheless, a significant main effect of partner type on commission errors in calm-nogo blocks was found, showing more commission errors on calm-nogo trials in the human (M=3.50, SD=2.66) than in the computer (M=2.37, SD=1.24) condition, $F(1,63)=4.21$, $p<.05$. Furthermore, a marginally significant Stress x Partner interaction effect on calm-go RTs was found, $F(1, 61)=3.78$, $p=.05$.

Table 8. Means and standard deviations for implicit emotion measures by condition in Experiment 2.

	Control				Stress			
	Computer		Human		Computer		Human	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Calm Commission Errors	1.86	1.23	2.22	2.65	1.31	1.6	3.10	2.94
Fear Commission Errors	1.79	1.48	2.11	2.19	2.38	3.25	2.20	2.76
Calm Ommission Errors	5.43	9.26	4.61	8.18	5.77	6.78	3.40	4.85
Fear Ommission Errors	3.00	4.06	2.72	4.65	3.69	7.05	2.35	2.58
Calm-go RTs	480.71	72.53	491.10	91.74	573.81	167.23	479.40	89.41
Fear-go RTs	464.47	117.64	463.55	65.02	485.62	65.68	471.08	103.97

<u>Trait emotion regulation</u>

Emotion dysregulation comprised of mean scores from three subscales (i.e., Goals, Impulse, and Strategies) of the Dysfunction of Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). The average scores for overall emotion dysregulation as well as each type of emotion regulation were calculated for the 65 participants, and high and low regulators were defined as those with scores above and below the average (M=2.25 for overall, M=2.88 for goals, M=1.90 for impulse, M=2.11 for impulse), respectively. There were 19 high emotion dysregulators (7 in stress condition), 46 low emotion regulators (26 in stress condition), 26 high goal dysregulators (12 in stress condition), 39 low goal dysregulators (21 in stress condition), 6 high impulse dysregulators (one in stress condition), 59 low impulse dysregulators (32 in stress condition), 12 high strategies dysregulators (four in stress condition), 53 low strategies dysregulators (29 in stress condition).

To test H3a in this experiment, two sets of analyses[18] were conducted. More specifically, a 2 (amount: fair vs unfair) x 2 (stress: stress vs control) x 2 (emotion dysregulation: high vs low) and a 2 (amount: fair vs unfair) x 2 (partner type: human vs computer) x 2 (emotion dysregulation: high vs low) mixed model ANOVA were conducted on rejection rates. No significant interaction effects on rejection rates were found between Amount x Stress x Emotion Dysregulation, $p>.4$, Amount x Stress, $p>.05$, or Amount x Emotion Dysregulation, $p>.1$. Additional analyses revealed no significant interactions when average scores for Goals Dysregulation, Impulse Dysregulation, and Strategies Dysegulation were entered separately. More specifically, a 2 (amount: fair vs unfair) x 2 (stress: stress vs control) x 2 (goals dysregulation: high vs low) ANOVA, a 2 (amount: fair vs unfair) x 2 (stress: stress vs control) x 2 (impulse dysregulation: high vs low) ANOVA, and a 2 (amount: fair vs unfair) x 2 (stress: stress vs control) x 2 (strategies dysregulation: high vs low) revealed no significant interactions, *p*s>.05. Next, no significant interaction effects on rejection rates were found between Amount x Partner Type x Emotion Dysregulation, $p>.6$, or Amount x Emotion Dysregulation, $p>.5$. Additional analyses revealed no significant interactions when average scores for Goals Dysregulation, Impulse Dysregulation, and Strategies Dysegulation were entered separately. More specifically, a 2 (amount: fair vs unfair) x 2 (partner type: human vs computer) x 2 (goals dysregulation: high vs low) ANOVA, a 2 (amount: fair vs unfair) x 2 (partner type: human vs computer) x 2 (impulse dysregulation: high vs low) ANOVA, and a 2 (amount: fair vs unfair) x 2 (partner type: human vs computer) x 2 (strategies dysregulation: high vs low) revealed no significant Amount x Partner Type x Emotion Dysregulation, $p>.8$, or Amount x Emotion Dysregulation interactions, $p>.2$. In sum, no interactive or main effects of emotion dysregulation were found.

[18] Two sets of 2 x 2 x 2 analyses were conducted, rather than one set of 2 x 2 x 2 x 2 in order to avoid overly complicated results.

To test H3b and H3c in this study, two sets of two-way ANOVAs were conducted on before-after UG change in negative emotions, with stress and emotion dysregulation as factors in the first set, and with partner type and emotion dysregulation as factors in the second set. First, a 2 (stress: stress vs. control) x 2 (goal dysregulation: high vs. low) ANOVA, a 2 (stress: stress vs. control) x 2 (impulse dysregulation: high vs. low) ANOVA, and a 2 (stress: stress vs. control) x 2 (strategies dysregulation: high vs. low) ANOVA were conducted on negative emotion change scores. Results showed a significant stress x goal dysregulation interaction, $F(1,65)=10.35$, $p<.01$[19]. Post-hoc ANOVAs revealed that among stressed participants, those low in goal dysregulation (n=21) reported a significantly higher *decrease* in negative emotions ($M=-.14$, $SD=.29$) than participants high in goal dysregulation (n=12, $M=.14$, $SD=.47$), $F(1,33)=4.56$, $p<.05$. In contrast, in the no-stress condition, participants low in goal dysregulation (n=18) reported a significantly higher *increase* in negative emotions ($M=.10$, $SD=.29$) than participants high in goal dysregulation (n=14, $M=-.24$, $SD=.51$), $F(1,33)=5.79$, $p<.05$.

Second, a 2 (partner type: human vs. computer) x 2 (emotion dysregulation: high vs. low) ANOVA was conducted on negative emotion change scores. No significant main or interaction effects on negative emotions were found, $p>.2$. Additional analyses revealed no significant main or interaction effects when average scores for Goals Dysregulation, $p>.2$, Impulse Dysregulation, $p>.5$, and Strategies Dysegulation, $p>.2$, were entered separately.

Finally, in order to examine the effect of stress on state impulsivity, a one-way ANOVA, with stress (stress vs. control) as the factor, was conducted on average state impulsivity. Interestingly, non-stressed participants ($M=2.21$, $SD=.34$) reported significantly higher state impulsivity than stressed ($M=2.00$, $SD=.35$) participants, $F(1,65)=5.91$, $p<.05$. Given the significant result, however, a 2 (state impulsivity: high vs. low) x 2 (offer: fair vs. unfair) ANOVA on rejection rates was conducted to examine whether state impulsivity, in turn, influenced rejections. This analysis revealed no interactive or main effects of state impulsivity on rejection rates, $F<1$.

Reaction Times

[19] A marginally significant Stress x Impulse Dysregulation interactivity, $F(1,65)=3.30$. $p=.07$. However, only 6 participants were classified as being high in impulse dysregulation, compared to 59 participants who were low in impulse dysregulation. Therefore, this interactivity may not be reliable. No significant Strategies Dysregulation x Stress interactivity was found, $F(1,65)<1$.

As in Study 1, the effect of stress on reaction times was tested with a one-way ANOVA on average reaction times, collapsed across trials, with stress (stress vs. control) as the factor. No effect of stress was found, $F(1,65)<1$.

Discussion

In the first study, there was an interactive effect of stress and offer amount on rejections, with mean rejections going in the predicted directions. However, Experiment 1 showed no mediation effect of negative emotions on the stress-rejection link, perhaps because stress did not influence the specific measure of negative emotions which was used in the study. In order to address the potentially problematic measurement, Experiment 2 addressed the mediation effect with a different method, namely by manipulating the negative emotions experienced. More specifically, Experiment 2 tried to address the mediation effect by adding the factor of partner type, which involved varying whether Responders received offers from human partners or computer partners. Since previous research has shown that Responders reject unfair offers less if they are made by a computer, relative to a human (Knoch et al., 2006; Sanfey et al., 2003), it was expected that in the stress condition, participants would not reject unfair offers more if they were made by a computer partner. This moderation of the stress-rejection link by partner type would lend support to the claim that emotions mediate the stress-rejection link.

First, pain ratings confirmed that participants in the stress, relative to control, condition experienced more pain during the task. Moreover, unlike Experiment 1, no interaction effects involving stress condition on rejection rates was found, and no trend was found in mean scores indicating an effect of stress on rejections of unfair offers. Thus, the result of the first experiment was not replicated in the second experiment.

Since no effect of stress on rejection rates was found, a mediation effect was not expected. Nonetheless, the hypotheses concerning a relationship between stress and negative emotions were examined, without the goal of showing mediation. Consistent with Experiment 1, no interaction or main effects of stress or partner type was found on explicit negative emotions. Thus, H6a and H6b could not be confirmed. However, unlike the first experiment, the present experiment indicated, when controlling for stress and partner type, a significant correlation between negative emotions and rejections of both unfair and offers. As with the mediation effect, since the stress-rejection link could not be established, the hypothesized moderation effect was not expected, but analyses were nonetheless conducted. Results showed no interactive or main effects of emotion dysregulation on rejection rates. On negative emotions as well, no interactive or main effects of emotion dysregulation were found, with one exception. Specifically, participants in the stress condition who have high difficulty in regulating their goals during distress, relative to those with low difficulty, showed a higher increase in negative emotions from before to after the Ultimatum Game. In contrast, non-stressed participants with high difficulty in regulating their goals during distress, relative to those with low difficulty, showed a higher decrease in negative emotions. Thus, as in Experiment 1, trait emotion regulation interacted with stress to influence negative emotion, but no hypotheses concerning the moderation effect could be confirmed.

Several unexpected but interesting findings emerged, especially in relation to the partner type factor. First, a significant Amount x Partner interaction revealed that participants in the human-partner condition rejected more unfair offers than those in the computer-partner condition. Furthermore, with the implicit emotion measure (i.e., emotional go/no-go task), a main effect revealed that participants in the human partner, relative to computer partner, condition made more commission errors for fear response (i.e., erroneous responses to neutral no-go stimuli). Such commission errors suggest that in the human partner condition, participants had more difficulty inhibiting a prepotent response for negatively valenced stimuli. Overall, it may be that participants in the human partner condition experienced a higher reactivity to negative stimuli, including unfair offers and faces expression negative emotion. Finally, state impulsivity was higher in non-stressed, compared with stressed, participants.

In sum, this experiment failed to replicate the core finding of Experiment 1 regarding the effect of stress on rejections of unfair offers. Furthermore, as in Experiment 1, there was no effect of stress on negative emotions. However, negative emotions were correlated with rejections of both fair and unfair offers, when stress and partner type were controlled. Regarding emotion regulation, of three subscales of emotion dysregulation, dysregulation of goals modulated the relationship between stress and negative emotions. Furthermore, unexpected findings suggest that interacting with a human partner, compared with a computer partner, during the Ultimatum Game is associated with stronger reactivity to negative stimuli.

Chapter V - General Discussion

The current research examines the effects of acute stress on social decision-making behaviors. Although there is substantial research showing effects of acute stress on non-social decision-making (e.g., Lighthall et al., 2009), research concerning effects of acute stress on social decision-making is relatively new. Therefore, in two experiments employing the Cold Pressor Test and the Ultimatum Game, the effect of acute stress on social decision-making was examined. One of the main aims as well as contributions of the current research was to extend current literature on stress and social decision-making (see Van den Bos et al., 2013) by examining the mediating and moderating roles, respectively, of negative emotions and emotion regulation.

During an acute stress response, it may be adaptive to engage in early as well as stimulus-driven responses to environmental stimuli. This may help an animal to prevent a disturbance from potential threats, and to automatically activate responses which are appropriate for specific eliciting stimuli. As previously suggested (Metcalfe & Mischel, 1999), these adaptive functions of the physiological mechanisms underlying an acute stress response may be carried out through an enhancement of emotional processing, but not cognitive processing. The rationale for this argument is that emotional processing is supposed to occur at an earlier time-point than cognitive processing (e.g., Murphy & Zajonc, 1993), and emotions are supposed to be generated in a stimulus-driven manner (e.g., Barrett et al., 2007), leading to stimulus-driven behavioral responses if control processes do not come into play. This assumption of the current paper that during an acute stress response, emotional processing is enhanced, is supported by empirical findings which show an effect of acute stress on reward salience (e.g., Lighthall et al., 2009) and emotional experience (Sinha et al., 2008). This effect of acute stress on emotions may be modulated, however, by emotion-regulation strategies related to cognitive processes (e.g., working memory; Schmeichel et al., 2008).

This link between stress and emotional processing relates to social decision-making in that emotions, in particular negative emotions, are supposed to increase reciprocal behaviors which, in the context of the Ultimatum Game, would mean increased rejections of unfair offers. Indeed, this prediction has been confirmed by findings which have shown a strong relationship between negative emotions and Ultimatum Game behaviors, namely rejections of unfair offers (e.g., Pillutla & Murnighan, 1999; Xiao & Houser, 2005). Putting the functional and information processing accounts of acute stress into the context of the Ultimatum Game led to the following hypotheses.

The most general prediction of the current research was that acute stress would, relative to a control condition, lead to increased rejections of unfair, but not fair, Ultimatum Game offers. The rationale for this general hypothesis constituted the mediation hypothesis of the paper, namely that stress would increase rejections of unfair offers by increasing the negative emotions associated with such offers. Furthermore, individual differences in the use of emotion regulation strategies, such as reappraisal and suppression (Gross & John, 2003), were expected to moderate the effect of stress on rejection rates by reducing either the experience or expression of negative emotions. These three main hypotheses were examined in two experiments, using the Cold Pressor Test as the stress induction method, and a 24-round Ultimatum Game with six offers each of 50%, 30%, 20%, and 10% being offered to each participant (each participant played the game as the Responder).

The general hypothesis that stress would increase rejections of unfair offers was partially confirmed in Experiment 1, with results showing a significant Amount x Stress interaction, with stress, compared to control, significantly affecting rejection rates. A previous study (von Dawans et al., 2012), however, found no significant differences in rejection rates between participants who experienced acute psychosocial stress and control participants, which contrasts with our finding. Foremost, since the result of the present paper was not replicated (discussed in more detail later), it should be noted that the result may not have been reliable.

This discrepancy may, however, also be due to the fact that there were some differences between the two studies. For example, the current study allowed Respondents to make only one decision whereas in the previous study (von Dawans, 2012), Respondents were allowed to make decisions for both if they were offered a fair offer and if they were offered an unfair offer (i.e., the strategy method was used). Furthermore, the present study employed physical acute stress while von Dawans and colleagues (von Dawans et al., 2012) employed psychosocial acute stress. This may be an important difference, because different types of stressors may have different underlying physiological mechanisms (Pacak, 2000). For example, there was a difference between stressors which required epinephrine release (e,g, formalin pain) and stressors which required metabolic activation (e.g., hemorrhage), with the former showing increases in catecholaminergic activity but not ACTH levels, and the latter showing the opposite pattern (Pacak, 2000). Cold pain (a type of physical stress) and restraint stress (a type of psychological stress) were also included in the study and showed different patterns of catecholamine and ACTH activities (Pacak, 2000). Although it is not clear what these findings would mean in terms of our study, they nonetheless seem to indicate that stress responses can be stressor-specific. These differences may indicate that the effect of stress on social decision-making is quite sensitive to the design of the experiment, as well as to which kind of stress is employed.

With regard to the mediation and moderation hypotheses, neither hypothesis was confirmed by the results of this research. More specifically, neither experiment showed that stress increased negative emotions or was associated with rejection rates, although the second study did show a partial correlation between unfair as well as fair offer rejections and negative emotion. Furthermore, the partner type factor, which was designed to reduce the negative emotions in response to unfair offers, did not influence negative emotions. Trait emotion regulation did not interact with stress or partner type to decrease negative emotion or rejections of unfair offers.

It should be pointed out that the mediation and moderation hypotheses could naturally not be confirmed, because the relationship between stress and rejection rates was not significant in the first experiment, and absent in the second one. There are, however, other potential reasons for why the expected relationships involving emotion and emotion regulation were not found. First, it may be that negative emotions as measured in our study do not increase with stress. Second, our specific method of stress induction, the CPT, may not lead to an increase in negative emotions. Consistent with this notion, in the studies reviewed earlier, the studies which found effects of acute stress on explicit emotion ratings (Sinha et al., 2008; Wang et al., 2005) employed psychosocial stressors, rather than physical stressors.

The disconfirmation of the hypothesis that low emotion regulators would reject more than high emotion regulators (H3a, Experiment 1) seems to contrast with the result that experimental induction of reappraisal of Ultimatum Game offers led to lower rejections of unfair offers (van't Wout et al., 2010). Two reasons for this may be that first, as suggested in the introduction, stress may have reduced state emotion regulation abilities, thereby making even high emotion regulators unable to control their emotions under stress. Second, trait reappraisal tendency and state experimentally induced reappraisal, which was employed in the study by van't Wout and colleagues (van't Wout et al., 2010), may have different effects on Ultimatum Game decisions.

Another disconfirmation was that reappraisal had no effect on self-reported negative emotions. This may mean that as measured in this experiment, trait reappraisal does not influence negative emotions (as measured here). Given previous findings showing that trait emotion regulation does correlate with negative emotions (Aldao et al., 2010; Gross & John, 2003), however, an alternative explanation may be more plausible for these results. In particular, there were much fewer low reappraisers (n=10) than there were high reappraisers (n=43), with only seven low reappraisers in the stress condition. Thus, there may not have been enough low reappraisers to produce a reliable average rejection rate for that group.

Although the mediation and moderation hypotheses could not be confirmed in either of the two experiments, other unexpected but interesting results emerged. First, high emotion regulators rejected significantly less fair offers, but not unfair offers, than low emotion regulators (Experiment 1). This result is interesting in that it contrasts with the initial hypothesis, which was that high emotion regulators would reject unfair offers less than low emotion regulators. The rationale for the initial hypothesis was that since people do not experience negative emotions toward fair offers, high emotion regulation would affect behaviors toward the emotion-inducing stimuli, that is, unfair offers. This argument implicitly assumed that negative emotions are not present for fair offers, but they are present for unfair offers. Therefore, emotion regulation strategies would reduce rejection rates only when there are negative emotions to regulate, but not when they are absent. Perhaps, the finding of a negative association between emotion regulation and rejection of relatively fair (but not equal) offers reflects that this assumption is inaccurate. Specifically, negative emotions, although present, may be weaker in response to 30% offers than the 20% and 10% offers. In that case, trait emotion regulation tendencies may be able to regulate the weaker emotional responses to relatively fair (but not equal) offers but not strong enough to control emotions from unfair offers. For unfair offers, an explicit instruction to regulate one's emotions may be helpful for regulating stronger negative emotions, as in previous research (van't Wout et al., 2010).

A second interesting finding involves the hypothesis concerning reaction times of stressed and control participants during the decision-making task. Based on the affective primacy principle (Zajonc, 1980, 1984) and the hypothesized functions of the physiological acute stress response, it was initially expected that acute stress would enhance early responding, reflected by faster decision-making in the stress, compared to control, condition. Experiment 1 showed, however, that the decision-making times were actually slower in the stress condition than control condition. A finding from previous research (Knoch et al., 2006) may help explain this discrepancy. More specifically, participants were faster to accept fair offers than they were to make a decision on unfair offers (Knoch et al., 2006). This finding was interpreted to mean that when there is a conflict between the selfish and fairness motives, such as when a person needs to decide whether to forfeit monetary reward for fairness, the decision is more time-consuming than when only one motive is active (Knoch et al., 2006). In the initial formulation of hypotheses, a stress response was thought to prepare an animal for engaging in behaviors with an early onset in order to prevent a disturbance. However, this function may only apply in situations with one clear motive, rather than multiple conflicting motives, such as when deciding whether to accept or reject an unfair offer. That is, when there is a conflict between motives, stress may not facilitate early onset of behavioral responses, and may even lead to slower resolution of the conflicting motives and decision-making.

Finally, results from Experiment 2 seem to confirm previous findings that partner type influences emotional experience during the Ultimatum Game (e.g., Sanfey et al., 2003). First, a significant Amount x Partner interaction revealed that participants in the human-partner condition rejected more unfair offers than those in the computer-partner condition. Furthermore, analysis of the implicit measure of negative emotions revealed that participants who received offers from human, relative to computer, partners had more difficulty inhibiting a negative emotional response (i.e., a fear response) after the game. Overall, it may be that participants in the human partner condition experienced a higher reactivity to negative stimuli, including unfair offers and faces expressing negative emotion.

Implications

Since the results of the present research were not reliably replicated in both experiments, it is difficult to discuss definitive implications of the findings. Nonetheless, from the interaction in Experiment 1, it may be suggested that acute physical stress adversely influences social decision-making outcomes. One real-world application of this claim could be in the context of social interactions in the workplace, where stress management intervention programs have been implemented to reduce the negative work outcomes of stress (for reviews of such interventions, see Richardson & Rothstein, 2008; van der Klink, Blonk, Schene, & Van Dijk, 2001). Given that stress can negatively influence social interactions involving perceived fairness, stress interventions geared specifically towards improving the social impact of stress may be helpful for workers to get along well even under stress. The stress intervention programs developed so far seem to mainly focus on protecting the physical and mental health of individual workers (see Richardson & Rothstein, 2008; van der Klink et al., 2001), but stress intervention programs specifically targeting the social effects of stress seem difficult to come across. Some existing stress intervention techniques which may be relevant include techniques involving social support, which may modulate the negative effects of stress (Cohen & Wills, 1985). Although the benefits of social support are not specific to social outcomes, if employees can get social support from other coworkers in order to reduce their stress, relationships between coworkers may improve and interactions may become more positive even when employees are stressed.

Aside from the practical implication, there are also some theoretical implications, especially with regard to implicit assumptions made by the current research. The theoretical framework regarding the function of a stress response was originally developed to describe mechanisms which occur in a prey-predator environment. Therefore, the theory had underlying assumptions, but those assumptions were not made explicit in this paper. These assumptions may have been true in the prey-predator environment, but not in the interpersonal negotiation environment, and that could have contributed to some of the hypotheses being incorrect. The following discusses three implicit assumptions of the theoretical framework which may not have been true in the experimental paradigm, and how these assumptions may have affected the results of the research. Specifically, the following discusses the certainty of the outcomes of decision, the nature of the decision, and the motives guiding the decisions.

In the framework of Nesse (Nesse, 2005), there is uncertainty regarding the outcome of the behavior of running away from a predator. This can be illustrated by the fact that this theory incorporates probabilities of specific outcomes (Nesse, 2005), rather than positing a certain outcome for a given action. In the experimental paradigm of this paper, however, the outcomes of behaviors were certain. That is, whereas the behavior of fleeing from a predator may or may not have resulted in the prey escaping, an accept decision would certainly result in a payment and a reject decision would certainly result in no payment. The claim that behavioral responses should be fast and stimulus-driven was developed under the assumption that outcomes of behaviors would not be guaranteed, but decisions in the Ultimatum Game do have guaranteed outcomes. This difference may make it more or less necessary for behaviors to be fast and stimulus-driven in the Ultimatum Game than in the prey-predator environment.

The second difference is in terms of costs and benefits of a decision. In the prey-predator context, the costs and benefits of actions are qualitatively different from those in the Ultimatum Game. For example, the cost of being attacked by a predator is not in terms of money, but in terms of life or limb. That is, the cost in a prey-predator context is physical, whereas in the interpersonal negotiation context, it is monetary. Due to this difference, fast and stimulus-driven action may be very adaptive in the prey-predator context, but may not serve as adaptive of a function in the interpersonal negotiation context. It may be that the effect of a stress response on decision-making may depend on the type of costs or benefits associated with the decision.

Third, in the prey-predator environment, the only goal of the prey animal is to survive and not be caught by a predator. In contrast to the prey-predator environment, in the Ultimatum Game, there are at least two goals, selfish and fairness goals (Knoch et al., 2006). Furthermore, when considering whether to accept or reject an unfair offer, the motives in the Ultimatum Game are competing, such that selfish motives would induce one to accept whereas fairness motives would induce one to reject. The competing motives in the Ultimatum Game may lead to a conflict which takes higher order cognitive processes (Lieberman et al., 2002) as well as time to resolve. In contrast, when there is only one motive, such as in the prey-predator environment, decisions may be made more quickly and more emotionally.

Limitations

The present research made an effort to address a gap in the newly emerging literature about stress and social decision-making by examining potential mediating and moderating factors of the relationship between acute stress and social decision-making. It also tried to bridge the functional and information processing perspectives regarding the effect of acute stress on psychological functioning. Furthermore, both experiments were incentivized with money, and provided a physiological measure to confirm the occurrence of an acute stress response in the first experiment. These may be considered strengths of the present research. Nonetheless, there are several important limitations which should be discussed.

First, the Stress x Amount interaction was not replicated in Experiment 2, with several possible reasons. First, the sample sizes of the second experiment were small, with three of the four between-group conditions having less than 20 participants. Second, whereas a successful stress induction was confirmed with cortisol analyses in Experiment 1, the absence of cortisol level tests could not confirm whether the stress induction in the second experiment was successful. Therefore, it may be that the null results in Experiment 2 were due to an unsuccessful stress induction. The insufficient sample sizes and lack of stress manipulation check with cortisol levels in the second experiment were mainly due to limited resources for paying participants and paying for cortisol analyses. However, it may be that even with a sufficiently large sample size and a confirmed stress induction, the effect may not have been replicated. In that case, the State Impulsivity Questionnaire (STIMP; Wingrove & Bond, 1997), which was added in the second study to examine state impulsivity, may have primed participants to be more or less impulsive in their decisions. Furthermore, it should be noted that the results of Experiment 1may have been due to chance. These considerations underscore the importance of first, having sufficiently large samples and a cortisol manipulation check, and second, exercising care with potentially priming materials.

Second, the participants may have differentially engaged in coping strategies during the stress task. This may be problematic, because coping strategies such as distraction have been found to be effective in reducing pain (McCaul & Malott, 1984), making the use of coping strategies a confounding factor which may have differentially influenced the effectiveness of the stress induction in the present research. In the current research, no instructions were provided for participants to focus on the pain or a distractor during the stress task, nor did we check to see whether participants distracted themselves during the stress task. Therefore, it is difficult to know whether participants were differentially engaging in coping strategies during the task, and whether such engagement may have reduced the effectiveness of the stress task in inducing a stress response. This highlights the importance of utilizing some method, for example, providing instructions for all participants to focus on the sensation produced by the water, to ensure that participants will not differentially engage in coping strategies during the cold pressor task.

As mentioned above, participants may have been primed by the questionnaires, including, but not only, the STIMP (Wingrove & Bond, 1997), which preceded the Ultimatum Game. Other relevant questionnaires included trait emotion regulation questionnaires given before the stress (or control) task as well as state emotion questions given just before and after the Ultimatum Game. It should be noted, however, that since the mediation and moderation hypotheses were important hypotheses for this research, it was necessary to include the emotion and emotion regulation questionnaires. Furthermore, having state emotion ratings only after the Ultimatum Game would have left unchecked a confounding factor, namely the initial emotional state of the participants. Nonetheless, it may be better in the future to include fewer emotion ratings (e.g., one valence rating) before the Ultimatum Game, and to ask participants to complete trait emotion regulation questionnaire on a different day, rather than during the experimental session.

A fourth methodological limitation of the current research is the use of deception. This could be a serious limitation, because participants may not have felt real emotions toward the Proposers if they did not feel that they were interacting with real people. Given the difference in rejection rates between human and computer partner conditions (Experiment 2), however, participants seem to have felt emotions in response to the offers which were at least stronger than they would have felt if the offers were from the computer. Nonetheless, it is important to try to make the experiment as realistic as possible, for example, by using a group stress induction procedure (e.g., von Dawans et al., 2012), and having participants gather in a group experiment setting so they can feel certain that they are playing with real partners (von Dawans et al., 2012).

In addition to methodological limitations, the present research contained some theoretical limitations. First, the theoretical framework of this research was very different from the experimental paradigm. For example, the evolutionary theory concerning the stress response was describing mechanisms which would take place in a prey-predator environment, whereas the experimental paradigm took place in an interpersonal negotiation environment. This may have been problematic in developing hypotheses, because some assumptions which may be true in the prey-predator environment may not be true in the interpersonal negotiation environment, leading the theory to make inaccurate predictions of the results of the experiment. To give a concrete example, one may state that gravitational force is 9.81m/s^2. The truth of this statement depends, however, on the specific location to which the statement is referring. More specifically, this statement is true on Earth, but may not be true in other locations, such as Mars, where gravitational force is only 38% of that on Earth ("Mars," n.d.). Similarly, in the prey-predator environment, there may be only one motive, which is to avoid being caught by a predator, whereas in the interpersonal negotiation environment, there may be two motives, a selfish motive and a fairness motive. In using a theory which describes mechanisms that occur in the prey-predator context, the present research made an implicit assumption that in the interpersonal negotiation environment, there is only one motive, and it may be because of this false implicit assumption that some predictions, such as the one regarding reaction times, were wrong. In the context of gravitational force, this would be equivalent to predicting how fast a ball would fall on Mars, assuming that the gravitational force on Mars is 9.81m/s^2. This would, of course, lead to an inaccurate prediction.

A theory which concretely defines the variables influencing social decision-making under stress as well as the relationships between the variables may help address this problem. Rather than creating a new model, the existing model by Rabin (Rabin, 1993), which includes both a monetary and fairness component, may be modified to include a stress variable. Previous research has made modifications to models, adding a weight to the fairness component, relative to the monetary payoff (e.g., Camerer & Thaler, 2003). The model of Rabin (Rabin, 1993) may also be modified to include weights for the monetary and fairness components as below.

$$U_i(a_i, b_j, c_i) = \alpha * \pi_i(a_i, b_j) + \beta * f_j(b_j, c_i) * [1 + f_i(a_i, b_j)]$$

α and β describe the weights for the monetary and fairness components, respectively. Stress may be incorporated into this modified model by making α and β functions of stress. For example, if stress is postulated to increase the weight of the monetary component, α could be defined as a positively correlated function of a person's cortisol levels, and if stress is postulated to increase the weight of reciprocity, β could also be defined as a positively correlated function of a person's cortisol levels. Although this paper does not attempt to develop a model linking stress with social decision-making, the model above and the suggestion of defining α and β in terms of cortisol levels may be a useful beginning.

Conclusion

The main claim of the present paper was that the physiological mechanisms underlying an acute stress response serves two adaptive functions, namely to quicken the onset of behavioral responses in the face of threat and to make the animal more sensitive and responsive to stimuli around it. These claims were based on previous assertions concerning the relationship between stress and emotional processing (Metcalfe & Mischel, 1999). In turn, these adaptive functions could be achieved psychologically through an enhancement of emotional, relative to cognitive, processing (Metcalfe & Mischel, 1999), because emotional processing is supposed to have an earlier onset (Zajonc, 1980, 1984) and be more stimulus-driven than cognitive processing. Functionally, these characteristics may help prevent disturbances to homeostasis and to activate adaptive innate or learned stimulus-response links, producing appropriate responses to eliciting stimuli.

In the context of the Ultimatum Game, the enhancement of emotional processing would mean that people under stress would make more emotional decisions, namely rejecting more unfair offers. In other words, stress was expected to lead to higher rejections of unfair offers, and this effect would be mediated by negative emotions. Furthermore, personality differences in emotion regulation tendencies were expected to moderate the stress-rejection link by influencing the experience and expression of negative emotions during the game. These hypotheses comprised the three main hypotheses of the present research: the main effect of stress on rejection rates, the mediation of that effect, and the moderation of that effect. In order to test these hypotheses, two 24-round Ultimatum Game experiments were conducted. The results were mainly disconfirming the hypotheses. Nonetheless, a significant interaction between stress and fairness, with a confirmed stress induction, suggests that it may be worth looking into this effect in future research.

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Appendix

Experimental materials for Experiment 1

Phone-screening:

"Please do not consume any food or drinks (except water) within 3 hours, do not sleep within two hours, and do not exercise within one hour prior to your appointment. Do you have any questions about your eligibility?"

Determining eligibility at recruitment

"I will administer a short questionnaire at this time."

Prior to consenting:

1. Stress prescreening form (aka: Exclusion questions) = We administer

This is an absolute criterion. Participants must not have any of these conditions. This form can be administered over the phone prior to coming in.

Prior to testing [does not have to be on testing day]: "Please complete the following questionnaires and let me know if you have any questions."

2. Health status form = Self-administered

Participants must not have any of the conditions in the top section. Discretion used for the conditions listed in the following sections.

3. "Morning-ness" question (wake/sleep patterns) = Self administered;

*Note: After initial screening, we check over the same forms above (besides the consent form) before the experiment. This is to ensure that nothing has changed since we last spoke with the participant.

When participant arrives:

"Welcome to our study. Before we start, I just need to ask a few questions. Have you consumed any food or drinks (except water) within 3 hours? Have you slept within two hours prior to coming in?Have you had vigorous exercise within one hour?" [If they answer yes to any of these, exclude or wait until appropriate time has passed if possible.]"

Explain to participants that we will get saliva samples from them and that they will drink water to create a cleaner sample. Ask if they'd like to use the restroom before drinking.
Ask the participant to drink the 8 oz bottle of water. Start a timer for <u>10 minutes</u>, first saliva sample can be no less than 10 minutes after finishing the water bottle.
Side note: This will allow for a cleaner saliva sample

3) Read the following introduction:

You will complete 2 separate experiments today. In the first study, we are interested in the relationship between personality and stress levels. You will fill out a few personality questionnaires and then you will be randomly assigned to complete a stressful task or a non-stressful task. In this task, half of the participants will hold their hand in ice water for up to three minutes in order to increase their stress hormones and the other half of the participants will put their hand in warm water. Holding one's hand in ice water is a safe and effective way to temporarily raise cortisol levels. To test your cortisol levels we will be taking samples of your saliva into a small plastic cap for a minute or two. I can't tell you ahead of time which condition you're in, but I need to make sure that you are fine with either one before we begin.

Approximately 30 min after the first stress task, we would like to ask you to repeat the same stress task again to determine how stable your reactions to stressors are. Thus, participants in the stress condition will be asked to put their hands in cold water twice, while those in the control condition will put their hands into warm water twice.

It is known that it takes at least 30 min to return to the original mental states once you get stress. Therefore, we need to wait at least 30 min before the second stress task. In the meanwhile, we would like you to work on a second experiment which is unrelated to the stress task.
In the second experiment, you will participate in an economic experiment in which you can earn money. Because it is very difficult to get multiple participants in the same location at the same time, you will interact with partners who are participating from the LMU Economics building and the Technical University in Munich. Some people will be in groups, and some will be participating individually in separate rooms. Generally speaking, we are interested in people's

decisions when interacting in close physical proximity and When interacting from distant locations. In the beginning of the experiment, you will be assigned to one of two roles by a computer lottery and will make decisions in that role for the rest of the experiment. For each round, you'll see a picture of your partner in that round. If you are ok with it, we'd like to take a picture of you to show to your interaction partners as well. Your picture will be kept confidential. May we take your picture now and upload it into our computer? Please stand against the wall with a neutral facial expression. The other participants are also taking their pictures for the experiment."

"At this point, if you feel uncomfortable about any of these procedures, please let me know." If they express concerns or hesitation, let them know that it is fine if they would prefer not to complete the experiment and that there will be no penalty if they want to leave at this point (of course, they will not be paid). "Also, please make sure if you have a cell phone with you that it is turned off."

4) Check over forms 1 and 2 (above): "Please look over your responses to the questionnaires to ensure that they are accurate and up-to-date."

5) HAND OUT THE CONSENT FORM. Collect the consent form and ensure that the participant has properly signed and dated the form.

6) "Please complete these forms. Some questions ask how you feel now and others ask how you feel in general, so please read the instructions carefully to understand which questions you are answering. I'll upload your picture while you complete the forms."

Upload the picture and start getting BOTH water conditions ready. "I'm just preparing both conditions to save time, but I don't know yet which condition you'll get."

CES-D (20 items; Depression; validated German version available)
Gross's emotion regulation questionnaire (10 items; German version available)
State and Trait Anger Expression Inventory (20 items; German version available)
Norm of Reciprocity form (27 items: needs to be translated)
Pain questionnaires (FRS and the VAS)

8) Collect saliva samples and note the time

*Note: Must do this before and after the water task

Put on gloves

Take 2 SaliCaps from the plastic bag.

Ask participant to use the straw to place saliva into the tube (we need 1mL in total, so ask the participant to fill up at least.5 ml in each tube).

Cap the container. Place tube in its properly marked container.

Repeat steps 2-4 so that we collect 2 samples for each time point.

Note: Make sure that the tube's label has the following information: 1) participant's ID number 2) the sample number 3) time of sample, and 4) date of sample.. The next saliva sample will be taken 15 minutes after the water task. Please record the clock time for this 1st saliva sample.

"We're going to do the stress task now, and fifteen minutes after the stress task, we'll collect another saliva sample."

Draw a paper from the cup to see which condition (warm or cold water) the participant is in, and let the participant know which condition they are in.

9) Stress/no-stress water task

Prepare the water condition you chose: either water at ice cold temperature (0-3°C) or water at room temperature (37-40°C). Use a thermometer to ensure the proper water temperature is reached.

Ask participant to submerge his/her non-dominant hand into the water pitcher and note the time.

Instructions for all: "Please submerge your non-dominant hand into this water pitcher and hold your hand in this container of water for as long as you can up to 3 minutes. Make sure your whole hand is submerged up to your wrist."

Record the time that the participant puts their hand in the water.

*Note: During this task, stay in continual eye contact with the participant. Conversing with the participant is fine. If you notice that he/she is struggling, tell him/her that they can remove their hand after 1 minute if they want. You may also want to verbally encourage him/her to keep their hand in for at least 1 minute.

After 3 minutes (or until the participant can no longer submerge his/her hand in the water), give him/her paper towels to dry off the hand. If the participant was in the stress water task, their hand will likely be red. Inform the participant that this is normal and that the redness will go away after 5-10 minutes.

"If your hand is red, it is normal, and it will go away after five or ten minutes."

Note: Please record (1) water temperature just before participants submerge their hands into the pitcher, and (2) clock time when participants pull out their hands from the pitcher.

10) Start the timer. Fifteen minutes after this task (as close as possible to this time), you should take the next saliva sample.

11) PAIN QUESTIONNAIRES (FRS and the VAS):

"Please complete the following questionnaire, reporting your peak pain during the water task."

"We need to wait fifteen minutes until collecting the second sample. In the meantime, we'll get started on the second experiment. The new experiment will be conducted on the computer at the other table. Please take a seat there."

"You will complete a brief rating about your current emotion before starting and after completing the decision-making experiment. These ratings will be kept confidential and your partners will never see these ratings. Please listen carefully as I read the instructions."

READ THE INSTRUCTIONS FOR THE AFFECT GRID AND GIVE THE PARTICIPANTS 4 EXAMPLES

While showing the first slide of the experimental program:

“In each round of this experiment, you and an actual partner in one of several locations (the Economics building or the Technical University)will split 10 euros between the two of you. Some people are grouped together in the same room, whereas others are playing from different locations. Any of the participants can interact with each other, and they won’t know whether they are in a group or in separate locations.”

While showing the second slide of the program:

“Each of these rectangles represents a person who is available to play with you in that round. You can click on one of the rectangles with the mouse to select your partner.”

“For every round, the same person will always decide how to split the money and the other person will always decide whether to accept or reject the offer. You will be assigned a role by a computer lottery, and neither you nor your partners will know how many rounds will be played. You will receive 10% of your earnings in cash at the end of the experiment. You will earn 5 euros for your participation in addition to the money from the experiment. Please start reading the instructions now.”

12) UG practice (Instructions from Moretti and diPellegrino, 2010)

You are now taking part in an economic experiment.

In this experiment, you will interact with real people via Internet who are now participating in this experiment from different locationsYou can earn some money depending on your decisions and those of the other participants. For this reason, it is very important that you read these instructions carefully. Please press the space bar to continue.

You will participate in the same basic interaction for several rounds. There are two different participant roles in each round: Participant A and Participant B. In each round you will be paired randomly with one partner. You will see a picture of your partner and your partner will see a picture of you. Importantly, you will NEVER play the game more than once with the same partner.

In each round, the experimenter will provide a fixed amount of money that must be divided between you and your partner. The amount that must be divided between you and your partner will be €10 in each round. Participant A will propose how the €10 is to be divided and Participant B will decide whether to accept or reject the proposal. Participant A will be free to propose any possible division of the €10. Please press the space bar to continue.

In the next slide, you will see two cards. The two cards represent a computer lottery which will determine whether you will be Participant A or Participant B in this experiment. Please click on one of the cards with the mouse to select which role you will take. You have a 50% chance of being Participant A and a 50% chance of being Participant B by choosing the card on the right side. The same is true for the card on the left side. In other words, you are equally likely to be Participant A or B. Please press the space bar to continue.

You have been assigned to be Participant B in every round. In other words, you will decide whether to accept or reject your partners' offers throughout the entire experiment. Press the space bar to continue.

Each time you learn about the proposal of Participant A, you must decide whether to accept or reject the proposal. Please press the LEFT key to ACCEPT the offer and press the RIGHT key to REJECT the offer. If you accept the proposal, the €10 will be divided according to the proposal. If you reject the proposal, Participant A does not receive anything but you also do not receive anything. The division procedure is finished and the round ends. You will do this for several rounds, but neither you nor your partners will know the exact number of rounds. Press the space bar to continue.

This game is played in real-time with multiple participants, and each participant will have up to 10 seconds to make his/her decision in order to prevent other participants from waiting too long. If you take longer than 10 seconds, neither you nor your partner will earn money for that round.

Ten percent of your entire earnings (that is, the sum of your earnings from each individual round) will be paid in cash in private at the end of the entire experiment. The other participants will not know the amount of your earnings. This concludes the instructions. Please let the experimenter know that you have finished reading the instructions.

Phone call: Ok, can you give me a minute to call the other research team? I just need to make sure our timing is coordinated. "Hi ____, about When do you think you'll be ready? Ok, in about x minutes? Great! Thanks."

"We need to wait for the others for a few minutes. Here is some reading material for the time that we wait." At this time, hand them the LMU history sheet.

13) When the 15 minute post water stress timer goes off (probably after participants read the UG instructions), obtain the second saliva sample (explain to the participant that they should make chewing motions to quicken saliva production). Hand the Salicaps to the participant while reading this script to the participant: "We will now take another saliva sample, the same way we did before. Please making chewing motions for about 30 seconds before giving your sample. Doing so will quicken your saliva production. Please use the straw to collect saliva. (Take the caps from the participant and place in the properly labeled container) Thank you."

Note: Make sure to record the clock time for the 2nd saliva sample.

"Now, you'll complete a few emotion ratings, do two practice rounds, and then start the actual rounds in which you will earn money for each round. Are you ready?"

.At this time, please indicate your current emotion by clicking on the following grid with your mouse and by clicking on the appropriate circles for the questions following the grid

Now you can do 2 practice rounds to familiarize yourself with how to play the game. You will not earn money for the 2 practice rounds but you will play with actual partners. Press the LEFT

key to ACCEPT the offer and press the RIGHT key to REJECT the offer. Please press the space bar to start the practice rounds.
The practice rounds are finished. Now, you can start the actual rounds in which you will earn money. Press the space bar to start the actual rounds.

14) UG game: 24 trials with 6 fair (5e) and 18 unfair (6 x 3e, 6 x 2e, 6 x 1e) offers.

The next task involves completing a few more questionnaires. Please let the experimenter that you are ready for the next task.

15) Last saliva sample collection. Note the time.

Post-experiment:
"Please indicate how you currently feel."

State Anger Expression Inventory (10 items; German version available)
Reward Sensitivity questionnaire
Justice Sensitivity questionnaire

We would like to ask you some questions about your emotional life, in particular, how you control (that is, regulate and manage) your emotions. The questions below involve two distinct aspects of your emotional life. One is your emotional experience, or what you feel like inside. The other is your emotional expression, or how you show your emotions in the way you talk, gesture, or behave. Although some of the following questions may seem similar to one another, they differ in important ways. For each item, please answer using the following scale:

1-------------2-------------3-------------4-------------5-------------6-------------7

strongly disagree	neutral	strongly agree

1. ____ When I want to feel more *positive* emotion (such as joy or amusement), I *change what I'm thinking about*.

2. ____ I keep my emotions to myself.

3. ____ When I want to feel less *negative* emotion (such as sadness or anger), I *change what I'm thinking about*.

4. ____ When I am feeling *positive* emotions, I am careful not to express them.

5. ____ When I'm faced with a stressful situation, I make myself *think about it* in a way that helps me stay calm.

6. ____ I control my emotions by *not expressing them.*

7. ____ When I want to feel more *positive* emotion, I *change the way I'm thinking* about the situation.

8. ____ I control my emotions by *changing the way I think* about the situation I'm in.

9. ____ When I am feeling *negative* emotions, I make sure not to express them.

10. ____ When I want to feel less *negative* emotion, I *change the way I'm thinking* about the situation.

Indicate on the line below the amount of pain you are experiencing right now (experienced from placing your hand in the ice). The further your mark is to the right, the more pain you are experiencing (experienced).

Fold on the dotted line!

Worst Possible Pain ________________________________ No Pain

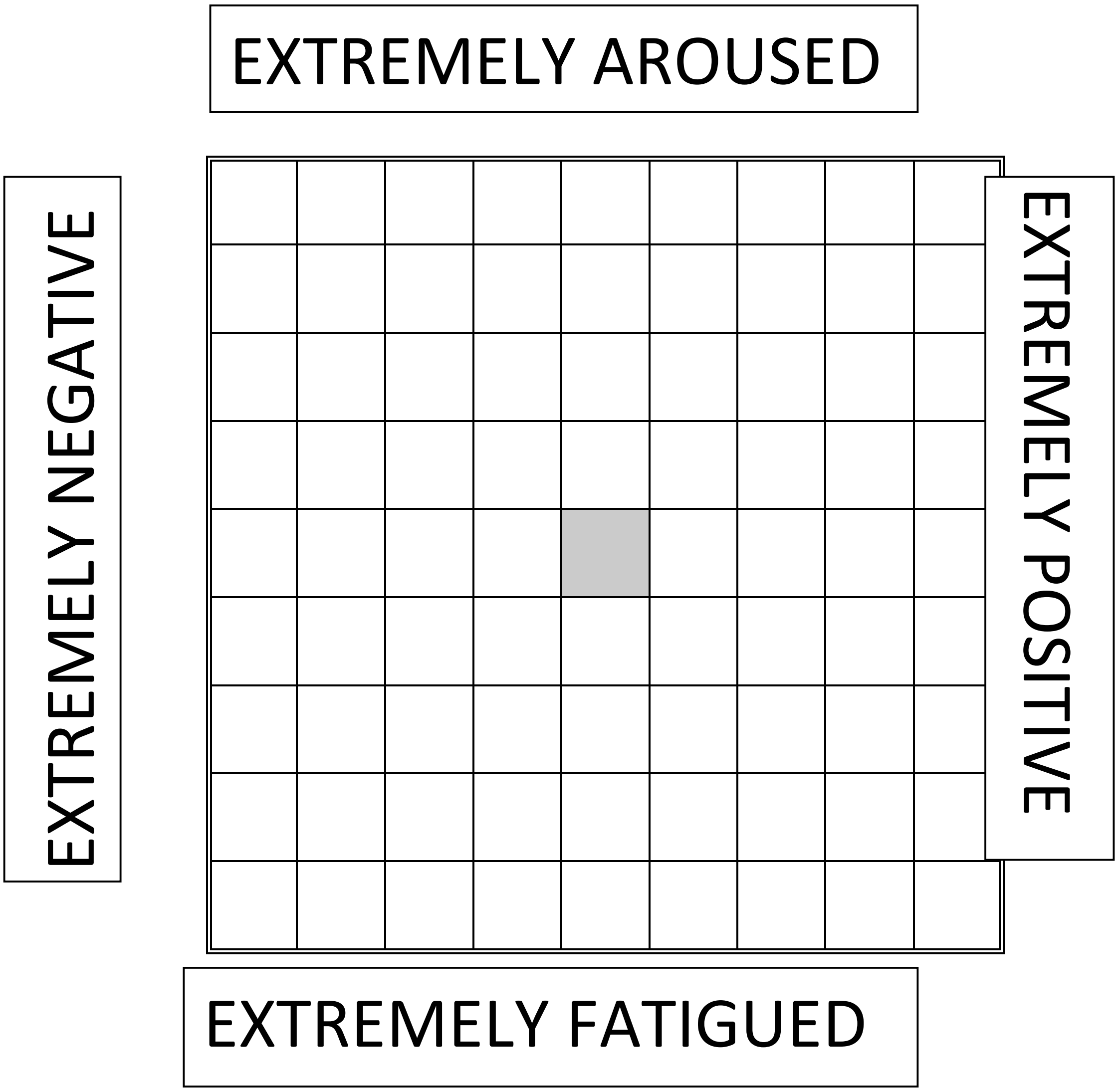
"These faces show different degrees of pain.

This face *[point to left-most face]* shows no pain.

The faces show more and more pain *[point to each from left to right]* up to this one *[point to right-most face]* – it shows very much pain.

Point to the face that shows how much pain you are experiencing now (experienced while placing your hand in the ice)."

Fold on the dotted line!



Please click on the cell that indicates your current emotion.

INSTRUCTIONS

In the next task, you will tell us about your current mood. For this purpose we will use a simple procedure (always have the matrix with you while giving these instructions). We are interested in two general types of states. First, we are interested in the emotional valence of your momentary mood - whether you feel quite good or quite bad. The degree of arousal is the second state we are interested in. The box in the center corresponds to a completely neutral state. From there, moving to the right indicates a more positive mood - from a little positive to moderately positive to very positive, and finally extremely positive. Moving to the left of the center, represents an increasingly negative mood – from a little to moderately to very negative and finally extremely negative. The same applies to the arousal assessment. For that assessment, your "energy state," so to speak, is important. The scale goes from there, very excited, full of energy, to extremely fatigued. Moving up from the center indicates an increasing level of excitement, and moving down indicates a decreasing state of arousal. During the second task, you will click with the mouse to indicate how you feel at that time. For example, if you feel just a little negative and feel a bit nervous, where would you click? If you however very happy and very excited, where would you click?

Experimental materials for Experiment 2

"Please look over your responses to the questionnaires to ensure that they are accurate and up-to-date and answer the questions on the 2^{nd} and 3^{rd} pages."

Prior to consenting:

1. Stress prescreening form (aka: Exclusion questions)

This is an absolute criterion. Participants must not have any of these conditions. This form can be administered over the phone prior to coming in.

Prior to testing [does not have to be on testing day]: "Please complete the following questionnaires and let me know if you have any questions."

2. Health status form = Self-administered

Participants must <u>not</u> have any of the conditions in the top section. Discretion used for the conditions listed in the following sections.

3. "Morning-ness" question (wake/sleep patterns) = Self administered;

<u>When participants arrives:</u>

"Welcome to our study. Before we start, I just need to ask a few questions. Have you consumed any food or drinks (except water) within 3 hours? Have you slept within two hours prior to coming in? Have you had vigorous exercise within one hour?" [If they answer yes to any of these, exclude or wait until appropriate time has passed if possible.]"

You will complete 2 separate experiments today. In the first study, we are interested in the relationship between personality and stress levels. You will fill out a few personality questionnaires and then you will be randomly assigned to complete a stressful task or a non-stressful task. In this task, half of the participants will hold their hand in ice water for up to three minutes in order to increase their stress hormones and the other half of the participants will put their hand in warm water. I can't tell you ahead of time which condition you'll be in, but I need to make sure that you are fine with either one before we begin.

Approximately 30 min after the first stress task, we would like to ask you to repeat the same stress task again to determine how stable your reactions to stressors are. Thus, participants in the stress condition will be asked to put their hands in cold water twice, while those in the control condition will put their hands into warm water twice.

It is known that it takes at least 30 min to return to the original mental states once you get stress. Therefore, we need to wait at least 30 min before the second stress task. In the meanwhile, we would like you to work on a second experiment which is unrelated to the stress task.

In the second experiment, you will participate in an economic experiment in which you can earn real money. In this experiment, the computer will randomly generate decisions in one of two roles. In the beginning of the experiment, you will be randomly assigned to one of the two roles and will stay in that role for the rest of the experiment, and the computer will stay in the other role for the rest of the experiment. The computer's decisions will be randomly generated, independently of your own decisions.

"At this point, if you feel uncomfortable about any of these procedures, please let me know." If they express concerns or hesitation, let them know that it is fine if they would prefer not to complete the experiment and that there will be no penalty if they want to leave at this point (of course, they will not be paid). "Also, please make sure if you have a cell phone with you that it is turned off."

4) HAND OUT THE CONSENT FORM. Collect the consent form and ensure that the participant has properly signed and dated the form.
5) "Please complete these forms. The questions ask how you feel in general, not at this moment. Please don't think too long about the answers and give your answers as quickly as possible."

Start getting BOTH water conditions ready. "I'm just preparing both conditions to save time, but I don't know yet which condition you'll get."

Difficulties in Emotion Regulation Scale (needs to be translated)

Eysenck Impulsiveness Scale

PAIN QUESTIONNAIRES (FRS AND THE VAS)

8) “We’re going to do the stress task now, and have a short break. Then, we’ll start the second experiment.”

Draw a paper from the cup to see which condition (warm or cold water) the participant is in, and let the participant know which condition they are in.

9) Stress/no-stress water task

Prepare the water condition you chose: either water at ice cold temperature (0-3°C) or water at room temperature (37-40°C). Use a thermometer to ensure the proper water temperature is reached.

Ask participant to submerge his/her non-dominant hand into the water pitcher and note the time.

Instructions for all: “Please submerge your non-dominant hand into this water pitcher and hold your hand in this container of water for as long as you can up to 3 minutes. Make sure your whole hand is submerged up to your wrist.”

Record the time that the participant puts their hand in the water.

*Note: During this task, stay in continual eye contact with the participant. Conversing with the participant is fine. If you notice that he/she is struggling, tell him/her that they can remove their hand after 1 minute if they want. You may also want to verbally encourage him/her to keep their hand in for at least 1 minute (and if they are struggling, let them know when 1 minute has passed).

After 3 minutes (or until the participant can no longer submerge his/her hand in the water), give him/her paper towels to dry off the hand. If the participant was in the stress water task, their hand will likely be red. Inform the participant that this is normal and that the redness will go away after 5-10 minutes.

“If your hand is red, it is normal, and it will go away after five or ten minutes.”

Note: Please record (1) water temperature just before participants submerge their hands into the pitcher, and (2) clock time when participants pull out their hands from the pitcher.

10) Start the timer. Twenty minutes after this task (as close as possible to this time), you should start the UG.

11) PAIN QUESTIONNAIRES (FRS and the VAS):

“Please complete the following questionnaire, reporting your peak pain during the water task.”

“Now we’ll get started on the second experiment. The new experiment will be conducted on the computer at the other table. Please take a seat there.”

“You will complete a brief rating about your current emotion before starting and after completing the decision-making experiment. These ratings will be kept confidential. Please listen carefully as I read the instructions.”

READ THE INSTRUCTIONS FOR THE AFFECT GRID AND GIVE THE PARTICIPANTS 4 EXAMPLES

While showing the first slide of the experimental program:

“In each round of this experiment, you will interact with the computer to split 10 euros. You will be assigned a role by a lottery, and for every round, you will do one of two things. You will either split the money in a way that is determined by the computer, or you will decide whether to accept or reject the offer made by the computer.”

While showing the second slide of the program:

“A question mark will show up at the beginning of each round. You can click on the question mark to start the round.”

“You will not know how many rounds will be played. You will receive 10% of your earnings in cash at the end of the experiment.”
“A few different computers will generate decisions (pointing to the laptop and PCs next to the participant’s chair). The computer’s decisions will be generated completely randomly, and will not be influenced by your previous decisions. Please start reading the instructions now.”

12) UG practice (Instructions from Moretti and diPellegrino, 2010)

You are now taking part in an economic experiment.

In this experiment, you will split a sum of money with the computer. You can earn real money depending on your decisions. For this reason, it is very important that you read these instructions carefully. Please press the space bar to continue.

You will participate in the same basic interaction for several rounds. There are two different roles in each round: Participant A and Participant B. In each round, the experimenter will provide a fixed amount of money that must be divided between you and the computer. You can think of this as an interaction in which a sum of money is being split between you and a partner. The amount that must be divided between you and the computer will be €10 in each round. Press the space bar to continue.

In the next slide, you will see two cards. The two cards represent a lottery which will determine whether you will be Participant A or Participant B in this experiment. Participant A will propose how the €10 is to be divided and Participant B will decide whether to accept or reject the proposal. Please click on one of the cards with the mouse to select which role you will take. You have a 50% chance of being Participant A and a 50% chance of being Participant B. In other words, you are equally likely to be Participant A or B. Please press the space bar to continue.

You have been assigned to be Participant B in every round. In other words, you will decide whether to accept or reject offers throughout the entire experiment. Press the space bar to continue.

Each time you see a proposal, you must decide whether to accept or reject the proposal. Please press the LEFT white key to ACCEPT the offer and press the RIGHT white key to REJECT the offer. Press the space bar to continue.

If you accept the proposal, the €10 will be divided according to the proposal. This would be equivalent to you accepting an offer from a partner, which would result in you and your partner receiving the proposed amounts of money. If you reject the proposal, the computer does not receive anything but you also do not receive anything. This would be equivalent to you rejecting an offer from a partner, which would result in neither you nor your partner receiving any money. Once you make your decision, the division procedure is finished and the round ends. You will do this for several rounds, but you will not know the exact number of rounds. Press the space bar to continue.

Please remember that each decision made by the computer will be randomly generated and independent of your own previous decisions. You will have up to 10 seconds to make your decision to accept or reject the offer. Similarly, you will wait up to 10 seconds for the computer to make an offer. If you take longer than 10 seconds to make your decision, the trial will be over and neither you nor the computer will earn money for that round.

Ten percent of your entire earnings (that is, the sum of your earnings from each individual round) will be paid in cash in private at the end of the entire experiment. This concludes the instructions. Please let the experimenter know that you have finished reading the instructions.

“We’ll take a short break and start in a few minutes. Here is some reading material for the time that we wait.” At this time, hand them the LMU history sheet.

STATE IMPULSIVITY QUESTIONNAIRE

“Please fill out this questionnaire now. This questionnaire asks you to indicate how you feel NOW.”

“Now, you’ll complete a few emotion ratings, do two practice rounds, and then start the actual rounds in which you will earn money for each round. Are you ready?”

At this time, please indicate your current emotion by clicking on the following grid with your mouse and by clicking on the appropriate circles for the questions following the grid

Happy
Angry
Proud
Anxious
Ashamed
Excited
Sad
Nervous
Pleasantly relaxed
Bored

Now you can do 2 practice rounds to familiarize yourself with the experiment. You will not earn money for the 2 practice rounds but the practice rounds will otherwise be identical to the actual rounds. Press the LEFT key to ACCEPT the offer and press the RIGHT key to REJECT the offer. Please press the space bar to start the practice rounds.
The practice rounds are finished. Now, you can start the actual rounds in which you will earn money. Press the space bar to start the actual rounds.

14) UG game: 24 trials with 6 fair (5e) and 18 unfair (6 x 3e, 6 x 2e, 6 x 1e) offers.

After the actual rounds, participants will complete the emotion ratings AND perceived fairness ratings.

You have finished all rounds. Once again, please indicate your current emotion by clicking on the grid and circles with the mouse. Press space bar to continue.

One moment please...
Our records indicate that you received offers of
Please type the number that describes how you felt about the
5€ offer
Extremely unfair Perfectly fair

The next task involves completing a few more questionnaires. Please let the experimenter that you are ready for the next task.

<u>Post-experiment:</u>
EMOTIONAL GO-NOGO TASK (on the computer)
ATTENTIONAL NETWORK TEST (on the computer)

Demographic information sheet

Debriefing with the participant
Have the participant complete the End-of-Study questionnaire
Distribute payment for participating in the study and for the money earned during the decision making game.

Please indicate how often the items apply to you in general.

PLEASE REMEMBER TO ANSWER EACH QUESTION

1	2	3	4	5
almost never	*sometimes*	*about half the time*	*most of the time*	*almost always*
(0–10%)	(11–35%)	(36–65%)	(66–90%)	(91–100%)

_____ When I’m upset, I feel guilty for feeling that way.

_____ When I’m upset, I feel ashamed with myself for feeling that way.

_____ When I’m upset, I become embarrassed for feeling that way.

_____ When I’m upset, I become angry with myself for feeling that way.

_____ When I’m upset, I become irritated with myself for feeling that way.

_____ When I’m upset, I feel like I am weak.

_____ When I’m upset, I have difficulty concentrating.

_____ When I’m upset, I have difficulty focusing on other things.

_____ When I’m upset, I have difficulty getting work done.

_____ When I’m upset, I have difficulty thinking about anything else.

_____ When I’m upset, I can still get things done.

_____ When I’m upset, I lose control over my behaviors.

_____ When I’m upset, I have difficulty controlling my behaviors.

_____ When I’m upset, I become out of control.

_____ When I’m upset, I feel out of control.

_____ I experience my emotions as overwhelming and out of control.

_____ When I’m upset, I feel like I can remain in control of my behaviors.

Instructions: Please answer each question by putting a circle around the 'YES' or the 'NO' following the questions. There are no right or wrong answers, and no trick questions. Work quickly and do not think too long about the exact meaning of the question.

Would you enjoy water skiing? YES NO

Usually do you prefer to stick to brands you know are reliable, to trying new ones on the chance of finding something better? YES NO

Would you feel sorry for a lonely stranger? YES NO

Do you quite enjoy taking risks? YES NO

Would you enjoy parachute jumping? YES NO

Do you often buy things on impulse? YES NO

Do you generally do and say things without stopping to think? YES NO

Do you often get into a jam because you do things without thinking? YES NO

Do you think hitch-hiking is too dangerous a way to travel? YES NO

Do you like diving off the highboard? YES NO

Are you an impulsive person? YES NO

Do you welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional? YES NO

Do you usually think carefully before doing anything? YES NO

Would you like to learn to fly an aeroplane? YES NO

Do you often do things on the spur of the moment? YES NO

Do you mostly speak without thinking things out? YES NO

Do you often get involved in things you later wish you could get out of? YES NO

Do you get so 'carried away' by new and exciting ideas, that you never think of possible snags? YES NO

Do you find it hard to understand people who risk their necks climbing mountains? YES NO

Do you sometimes like doing things that are a bit frightening? YES NO

Do you need to use a lot of self-control to keep out of trouble? YES NO

Would you agree that almost everything enjoyable is illegal or immoral?

YES NO

Generally do you prefer to enter cold sea water gradually, to diving or jumping straight in?

YES NO

Are you often surprised at people's reactions to what you do or say? YES NO

Would you enjoy the sensation of skiing very fast down a high mountain slope?

YES NO

Do you think an evening out is more successful if it is unplanned or arranged at the last moment?

YES NO

Would you like to go scuba diving? YES NO

Would you enjoy fast driving? YES NO

Do you usually work quickly, without bothering to check? YES NO

Do you often change your interests? YES NO

Before making up your mind, do you consider all the advantages and disadvantages?

YES NO

Would you like to go pot-holing? YES NO

Would you be put off a job involving quite a bit of danger? YES NO

Do you prefer to 'sleep on it' before making decisions? YES NO

When people shout at you, do you shout back? YES NO

Do you usually make up your mind quickly? YES NO

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS

Instructions: The following section includes a series of statements with which one can describe him/herself. Please read each statement and select from the four choices the choice which indicates how you feel now, at this moment. For each statement, please mark the number below your chosen answer.

There are no right or wrong answers. Please don't think too long and remember to select the one response that describes your present state best.

PLEASE REMEMBER TO ANSWER EACH QUESTION

	Über-haupt nicht	Ein wenig	Ziem-lich	Sehr
I behave spontaneously	1	2	3	4
It is hard to control my actions	1	2	3	4
I say whatever comes into my head	1	2	3	4
I do things in a slap-dash way	1	2	3	4
I tend not to think about consequences of actions	1	2	3	4
It is hard to think straight	1	2	3	4
It is hard to take in what's going on around me	1	2	3	4
I am easily caught off guard	1	2	3	4
I am easily distracted	1	2	3	4
It is difficult to concentrate	1	2	3	4
I tend to be impatient	1	2	3	4
I feel restless	1	2	3	4
I find waiting difficult	1	2	3	4
I want to get things done quickly	1	2	3	4

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS