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ECONOMIC DECISION-MAKING UNDER CHRONIC STRESS: BEHAVIORAL AND PSYCHOENDOCRINOLOGICAL ASPECTS

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DEDICATION

To Marcel and Maya, for existing.

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Introduction

Stress has become a prominent topic in the recent years, both in scientific research and media talking points. This is no surprise, since more and more surveys underline the fact that it is an increasing presence in the life of a growing part of the population and more and more research confirms that prolonged stress alters body- and possibly mental-functioning, being a precursor of serious disease (McEwen, 2004; McEwen, 2007). While the scientific evidence concerning the physiological effects of prolonged stress is continuously blooming, that concerning the effects it might have on cognitive mechanisms, higher-order cognition, behavior and decision-making processes is very restricted. Yet, considering that stress is a universal response and its chronicity potentially impacts a significant part of the population who must take private and professional optimal decisions, it is paramount to understand if and how chronic stress impacts individual and social decision-making.

This inquiry is intrinsically important, irrespective of economic cycles, because stress occurs indiscriminately and it is now established that decision makers' rationality is biased and potentially subject to psychological and physiological influences (Camerer, 1998; Glimcher and Fehr, 2013). However, this interrogation becomes especially relevant in times of economic crisis, when stressors multiply (see APA reports below or Faresjö et al., 2013) and, more than ever, optimal decision-making is necessary to rationally utilize or divide resources and derive the greatest possible benefit for both self and society as a whole.

Throughout the outbreak of the recent economic crisis, the American Psychological Association's yearly report, "Stress in America", highlighted the fact that stress is on the rise and that chronic stress is becoming a public health problem not only for adults, but also for teenagers and smaller children (Anderson et al., 2010; Anderson et al., 2012; APA, 2011; APA, 2013; APA, 2014; APA, 2015). The main stressors individuals identified were money and finances, but, despite this burden, emotional support was singled out as a potentially efficient stress buffer. However, reports focusing on stress management strategies determined that, most often, individuals will accelerate the damaging effects that chronic stress has on health by making poor dietary choices or adopting high-risk behaviors like smoking, drinking, or inactivity (for instance in APA, 2007). And,

worth noting further, even though the problems created by prolonged stress appear to be universal and range so far as to degrade social relationships (APA, 2007), there is a gender difference in stress perception, with women reporting higher stress levels and more stress-specific physical and psychological symptoms than men.

In brief, these recent yearly reports underlined the fact that people seem to take poor decisions under stress, and the one stress buffer that might function well, social support, is itself affected by stress. Further, stress appears to be chiefly caused by one´s financial situation and it appears to bear stronger on women than on men. Decisions, therefore, and, pertinent in everyday life and mostly during a crisis, financial decisions, are being taken under stress by a growing fraction of the population. These survey findings open two main experimental research avenues that are up-to-date unexplored: they indicate that stress might impact genders, with different magnitudes, by hindering one's ability to weigh risks and benefits, and that stress could ram the way that social relationships are perceived, nourished, and thus valued. It is precisely this the aim of the present thesis: to initiate experimental research on chronic stress, higher-order cognition and behavior, by deriving a bird´s eye view over gender-specific decision-making and social preferences under chronic stress in financially-motivated behaviors.

The investigation will be initiated by shedding light on decision-making in uncertain contexts. The first study presents a standard risk-taking paradigm (for instance, similar to Buckert et al., 2014) and investigates if, and to what extent, perceived and biologically measured chronic stress affects women´s and men´s risk-taking. This is especially relevant since everyday decisions often have uncertain outcomes and are themselves the exit route from problematic physiological and psychological states. Furthermore, since money is a source of stress, the object of many decisions, and a mean of improving one's current state, financial risk-taking will be experimentally employed as a reliable, relevant model for general, motivation-driven decision-making.

The second research avenue, concerning if and how social preferences *per se* are affected by chronic stress, will then be approached and examined. In the second study, the biological measure of stress is abandoned, since, as revealed in the first study, there is a misalignment between the two types of measures and they might therefore reflect different concepts and determine related, yet distinctive mechanisms. Until further research clarifies the golden standard for the biological assessment of chronic stress, the main aim of this thesis is pursued with a validated, self-reported measure: social preferences are evaluated under perceived chronic stress in a well-established social

decision-making task, the Dictator Game (Forsythe et al., 1994). Particularly important, social preferences are determined in various gender-pairing conditions, since evolutionary psychology suggests that not only gender, but also paired gender may determine social behavior under stress.

Finally, the third study will conclude the dissertation. It builds upon the experimental setting used in the second study and derives important methodological remarks regarding gender, gender-pairing, and framing in social decision-making task design. These contributions are compelling for both the study of social decision-making in general, and experimental and behavioral economics, in particular.

The experimental setting of the research that follows belongs to behavioral and experimental economics, and integrates methods and presumptions from neuroeconomics. These fields offer the opportunity of solid, thorough and reliable experimental practices with high experimental control, while integrating measurements of physiological and psychological variables. The next section identifies the literature gap that enables the study of economic decision-making under chronic stress and outlines the scientific context of the three studies by concisely describing the state-of-the-art of the involved fields and shortly defining the concept of stress.

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Background

The investigation of economic decision-making under stress is firstly important because it informs research about common choice in a significant part of the population. Secondly, economic decision-making, besides the fact that represents a large array of everyday decisions that are ultimately motivated by optimal allocations of resources, could also serve as a study platform for the category of decisions that are not financially-motivated, but motivated nonetheless. For long, decision makers have been thought of as perfectly rational, following a unique goal: the maximization of own benefit or payoff (Gigerenzer and Selten, 2002; Edwards, 1954). This entitles two associated ideas. For one, thinking and reason are the only determinants of rational choice. Second, within an individual's utility or expected utility function nothing beyond own benefit is included, thus accounting for alterity is excluded.

It is behavioral economics that, through broad experimental evidence, has shifted this *homo economicus* view towards a more factual account of human motivation (for instance, Camerer, 2004). Investigating decision-making, its motivations, and underlying mechanisms, behavioral economics has uncovered and integrated psychological and other internal or contextual variables in the rational decision-making models (Camerer and Loewenstein, 2004). As such, individuals are no longer defined as perfectly rational, and their decisions are described more accurately, being subject to various biases (Kahneman and Tversky, 1979). These biases can be reduced if decisions are incentivized, and behavior approaches more rational predictions, though it does not turn to perfect rationality (Engelmann and Strobel, 2000). This last discovery has entered the realm of experimental economics and became a standard experimental feature: financially-motivated behaviors reveal true preferences, by excluding interferences form concurrent, confounding motivations. Another imperative practice for yielding true preferences, for obvious reasons, is the lack of deception. Ergo, behavioral economics has not only helped develop more inclusive, genuine models of human decision-making, but has contributed to the settlement of equitable experimental practices that are included and, to some extent, challenged in the three studies that follow.

Allowing for psychological and contextual variables to add to the rational models explaining decision-making has opened up another realm of possibilities. Namely, the recently developed field of neuroeconomics has extended the investigation into the biological foundations of behavior and decision-making (Glimcher and Fehr, 2013). In neuroeconomics, the brain regions at work are non-invasively scrutinized and peripheral physiological markers are measured in order to obtain objective assessments of the individual's bodily activation patterns and to connect them to behavioral outcomes.

What is more: economics and, especially, behavioral economics have been preoccupied with explaining decisions endorsing trust, competition, risk-taking and delay discounting. While with behavioral measures several interesting conclusions have been derived, like the fact that there are marked gender differences in some of these behaviors (Eckel and Grossman, 2008; Niederle and Vesterlund, 2005; Schwieren and Sutter, 2008), neuroeconomics has further encouraged investigations into the psychoneuroendocrinological bases of behavior. For instance, testosterone has made its way into experimental economics and has been successfully investigated in relation to monetary delay discounting, distrust, social preferences, and risk-taking (Stanton et al., 2011; Takahashi et al., 2006; Zak et al., 2005; Zak et al., 2009). A second avenue of psychoneuroendocrinological research that has been embraced concerns stress. Thanks to the opening towards psychological factors and external influences from behavioral economics, and the new toolset of neuroeconomics, stress has begun to capture the attention of numerous researchers.

Without doubt, the domain of economic decision-making that has been most investigated under the influences of stress is risk-taking. While only one pharmacological study explored the effects of prolonged exposure to the main stress hormone[1] on risk attitudes, measuring some form of chronicity (Kandasamy et al., 2014), numerous studies have followed changes in risk-taking behavior after acute, momentary stress induction in the laboratory (for a review see Starcke and Brand, 2012). The current conclusion is that prolonged exposure to the main stress hormone decreases risk-taking, while exposure to acute stress affects risk-taking, but the direction in which it does is still subject to debate (for a thorough discussion see Buckert et al., 2014). Some authors report that risk-taking increases under acute stress (for instance, Lighthall et al., 2009; Starcke et al., 2008; van den Bos et al., 2009), while others report different findings (Delaeny et al., 2014; Gathmann et al., 2014). Importantly, it seems that, at least under acute stress, the gender differences

[1] Cortisol is the main stress hormone; but stress activates two bodily systems, the Hypothalamic-Pituitary-Adrenal Axis (HPA), quantifiable through cortisol, and the Sympathetic-Adrenal-Medullary Axis (SAM), quantifiable through, for instance, epinephrine or salivary alpha amylase (Nater et al., 2006; Whishaw and Kolb, 2005).

in economic behavior, e.g., risk-taking, are exacerbated: women choose even less risky options, men choose even more (Preston et al., 2007; Lighthall et al., 2009).

The other two domains of economic decision-making that have been explored under the effects of stress are social decision-making[2] and delay discounting. If the first route has just been opened in von Dawans and colleagues (2012) and increased prosociality is reported in connection to acute stress, the second beneficiates already of several explorations, yielding heterogeneous results (Fields et al., 2014). Some authors do not find any effect of acute stress on intertemporal choice (Haushofer et al., 2013), while others find increased delay discounting rates in cortisol responders (Kimura et al., 2013); and still others find increased delay discounting rates with concurrent low self-reported perceived stress (Lempert et al., 2012).

In sum, stress appears to influence economic decision-making and the initial evidence encourages further scrutiny. Nonetheless, the studies are limited in number and have focused on acute stress. While this offers much needed basic understanding of how neurophysiological processes momentarily affect higher-order cognition and behavior, it should not be neglected that, as detailed above, stress is often found in its chronic form in a growing part of the population and might have more permanent effects on economic decisions, and thus behavior. Moreover, given the difference between acute and chronic stress, knowing the direction of the effects acute stress has on economic decision-making might not shed light also on the effects of chronic stress.

Although the two concepts refer to the metabolic-activation response to an uncontrollable or unpredictable demand upon a body's resources, the difference they code regards exposure periods. Acute stress is a momentary response that provides adaptation for survival, while chronic stress refers to repeated or prolonged acute stress. It is well known that acute stress can have also beneficial effects, while chronic stress triggers mostly damaging effects upon body and, importantly, brain structures involved in cognitive processes and decision-making (McEwen, 2004). In the light of this evidence, chronic stress is granted a line of research of its own, in connection to, but disambiguated from acute stress. Moreover, the limited character of the knowledge about chronic stress extends beyond cognitive effects. If acute stress is validly assessed through momentary hormonal and arousal markers, chronic stress is mostly assessed through self-reports, since there exists no reliable biological measure for it. Against initial hypotheses, perceived chronic stress appears not to be connected to existing measures for prolonged stress hormone exposure (for

[2] In the form of social preferences (e.g., interpersonal altruism, fairness, reciprocity, inequity aversion), which is why these two concepts will be used interchangeably throughout this thesis.

instance, Stalder and Kirschbaum, 2012), which further complicates the understanding of the mechanisms underlying behavioral changes and changes in decision-making under chronic stress.

Given this current problem, the first study of this thesis will not only lay the ground for the development of a new research line on economic decision-making and chronic stress, but will also contribute to the debate concerning biological and self-reported measures of chronic stress. If one of the most prevalent economic decision-making domains in behavioral economics is explored in the first study, i.e., risk-taking, the second study will expand on the connection between chronic stress and a highly important type of decision in everyday life: social decisions, as measured by social preferences. Finally, since gender differences have been a staple finding in behavioral economics, experimental economics, and stress research, and will also become evident throughout the first two studies in this thesis, the third study will comprise methodological aspects regarding the experimental scrutiny of gender specific behaviors and gender interactions. Finally, the experimental tasks employed throughout this thesis are routinely used and have been widely explored in behavioral economics, and became standard references for valid laboratory investigations of behavior, assuring that this initial scrutiny of the effects of chronic stress on economic decision-making will provide reliable and replicable evidence.

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Chronic Stress Is Positively Related to Risk-Taking in Young Adults[3]

Abstract

Chronic stress is a public health problem that affects a significant part of the population. While the physiological damage it causes is under ongoing scrutiny, its behavioral effects have been overlooked. This is one of the first studies to examine the relation between chronic stress and decision-making, using a standard uncertainty paradigm. We measured learning-independent risk-taking in the gain domain through binary choices between financially incentivized lotteries. We then measured self-reported chronic stress with the Trier Inventory for the Assessment of Chronic Stress (TICS). We additionally collected hair samples from voluntary participants, in order to quantify chronic cortisol exposure. We discovered a significant, positive correlation between self-reported chronic stress and risk-taking that is stronger for women than for men. This confirms part of the findings in acute stress research: there is a clear connection between high stress and increased risk-taking. However, unlike the biologically-based results from acute stress research, we did not identify a significant relation between hair cortisol and risk-taking behavior. Yet, in line with previous literature, we found a clear gender difference in risk-taking and self-reports: women generally take less risk and report slightly higher stress levels than men. We conclude that perceived chronic stress might impact behavior in uncertainty conditions and that there might be differences in uncertainty and experience processing between men and women. Still, further research is necessary in order to unveil the mechanism accounting for these behavioral effects, while motivating the divergence between biological and psychological chronic stress measurements.

Keywords: Chronic Stress · Gender Differences · Risk · Self-reported Measures · Hair Cortisol

JEL Classification: C91 · D81 · D87 · J16

PsycINFO Classification: 2340 · 2560 · 3360

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1 Introduction

Stress is a domain of research that has increased in popularity in recent years. The reason for this heightened interest is the fact that stressors have multiplied proportionally with the amount of political and economic uncertainty in the contemporary world, and more and more individuals of all ages are affected by it (Anderson et al., 2010). Stress as a physiological phenomenon is double-sided: it has initially evolved as a useful, acute response to threat or challenge that marshals metabolic resources to adapt the body to short-term survival needs. However, when prolonged or having multiple sources, stress fosters chronicity, which leads to disease and degradation of bodily systems, including those involved in cognition and decision-making (Cacioppo, 1994; Gianaros et al., 2007; Juster et al., 2010; Lupien and Lepage, 2001; Lupien and McEwen, 1997; McEwen, 2004; McEwen and Sapolsky, 1995). Despite this status quo, the knowledge of how exactly chronic stress affects cognitive mechanisms, decisions, and thus behavior remains limited.

It is especially important, if chronic stress significantly alters cognition and decision-making processes, to uncover to which extent and in what manner this happens, because it is through optimal and functional decisions that physical and psychological health is re-established and behavioral patterns that can further endanger the individual are broken. Moreover, these decisions, either individual or social, are taken in uncertainty conditions, and stress might even further distort the way options are evaluated or information about alternatives is perceived. We refer here in laymen terms to uncertainty as a state of the world in which individuals do not have any guarantee that the option they chose out of all possible alternatives will always yield the outcome they expect[4], independent of any other conditions.

For instance, given a certain disease, there might be alternative treatments available, but no full assurance that one of them is going to provide the cure in each and every situation[5]. Instead, based on scientific studies, observations and health records, there is a certain probability associated with each of the treatments' success rates. The decision then is defined by choosing between these treatments or no treatment at all[6]. This type of situation, where one knows the possible outcomes of

[4] We continue using the term "uncertainty" below in the economic sense, and will refer to it as defined by Ellsberg (1961), to include both risky and ambiguous situations.

[5] In fact, the existence of multiple alternatives in a decision could already be considered a proof of uncertainty: if only one option would exist where the outcome is known and it occurs at all times, in all conditions, then there would be no further need for alternative options.

[6] Choosing no treatment at all can bring about several different outcomes, as well, but, for the purpose of categorizing the types of uncertain situation, we suppose the outcomes of refusing all treatments are known, as well as their respective probabilities.

the different options involved in a decision and the probability associated to the occurrence of each of the outcomes, is known in the economics literature as a risky situation. In contrast, one could face a newly discovered or less understood disease for which treatments have not been fully developed yet. In this situation, there might exist an experimental treatment that has just been discovered and it could yield several outcomes: curing, ameliorating, aggravating, or not curing the disease. However, since the treatment is experimental, no one knows what the probability associated with any of these outcomes might be. The decision then is defined by choosing between this treatment and no treatment at all[7]. This type of situation, where one knows the possible outcomes of the different options involved in a decision but not the probability associated to the occurrence of each of the outcomes, is known in the economics literature as an ambiguous situation. Of course, situations in the world are not only risky or ambiguous, but there is an entire continuum ranging from full certainty, where an outcome occurs every time, to full uncertainty, where not all outcomes and none of their probabilities are known (see, for instance, Starcke and Brand, 2012). Nonetheless, given the uncertain character of most situations, modeling decisions in standard paradigms as either risk or ambiguity can prove to be a valuable resource in reliable and replicable decision-making research.

In fact, in both experimental economics and stress research decisions have been modeled in the laboratory as either risky or ambiguous decisions (see, for instance, Buckert et al., 2014; Starcke and Brand, 2012). Stress research has mainly focused on using financial risk-taking paradigms to study decision-making under stress. Even though most experimental work in the stress and decision-making field concentrated on acute stress and results are heterogeneous in terms of direction, the current conclusion is that decision-making under acute stress is altered (Starcke and Brand, 2012). This finding is not only relevant for overstressed stock traders that influence entire economies, but also for other vulnerable groups as, for instance, public employees dealing with emergency situations - like firemen, medical doctors, or policemen (Trautmann, 2014). Moreover, under the premises of increasing stress in the contemporary society and the uncertain character of most decisions individuals face daily, the fact that stress affects decisions under uncertainty becomes relevant for all individuals, especially since it has been shown that cortisol levels[8] increase with increasing contextual uncertainty (Coates and Herbert, 2008). Finally, a third premise justifies our avenue in the present study: with increasing levels of stress, prolonged exposure to stress and

[7] Here we suppose the outcomes of not taking the experimental treatment are known, but their occurrence probabilities are unknown.
[8] Cortisol is the main stress hormone; it is employed as a biological marker of the stress response.

the multiplication of stressors, not only acute stress, but also stress chronicity might impact decisions in uncertain situations. We thus propose one of the first investigations of decision-making under chronic stress[9] and chronic cortisol exposure and aim to assess if the reported effects of momentary stress on decisions maintain, especially those on risk-taking.

2 Literature

Stress has been defined as the specific physiological response that the body initiates when confronted with an unpredictable or uncontrollable demand, i.e., a threat or a challenge[10], which triggers changes in homeostasis (Koolhaas et al., 2011). This acute, momentary response comprises the activation of the Hypothalamic-Pituitary-Adrenal (HPA) Axis, assessable through cortisol release, and the activation of the Sympathetic-Adrenal-Medullary (SAM) Axis, assessable through epinephrine release or salivary alpha amylase (sAA) (Kirschbaum and Hellhammer, 1989; Nater et al., 2006; van Stegeren et al., 2008; Whishaw and Kolb, 2005). If this type of acute activation is either repeated or prolonged, the stress becomes chronic and the bodily systems become exhausted, paving the way for disease (McEwen, 2004). Up to date, there is no measure as robust and valid for chronic stress as the salivary or plasma cortisol and salivary alpha amylase for acute stress[11], even if several biological measures have been explored (Cacioppo et al., 1998; Dickerson and Kemeny, 2004; McEwen, 2000; Pruessner et al., 1999; Wüst et al., 2000) and some offered very optimistic perspectives (Klein et al., 2004; Stalder and Kirschbaum, 2012a). However, for both acute and chronic stress, there is another measurable facet: the perceived experience.

Several self-report measures have been developed for chronic stress (Cohen et al., 1983; Fliege et al., 2005; Levenstein et al., 1993; Schulz et al., 2004) and, in acute stress research visual analogue scales and momentary emotional assessments are often utilized (for instance, see Kirschbaum et al., 1999). Given these different facets of stress, two natural questions arose: the first question regards the correlation between physiological measures of stress and the self-reported

[9] Throughout this study we refer to chronic stress as the perceived, self-reported facet of stress, while to chronic cortisol exposure as to the longer-term exposure to increased cortisol secretion. However, as will be discussed later, because of a limited sample size of hair donators, we refrain from advertising, underlining, or advancing concluding statements in connection to chronic cortisol exposure and its relation to perceived chronic stress and decision-making.

[10] The way this external or internal demand is perceived, i.e., either as challenge or threat (thus dealing with positive stress, eustress, or negative stress, distress), can influence the magnitude of the stress response and the strain it places on the bodily systems (see more on appraisal in Lazarus, 1990).

[11] But see important considerations (Hansen et al., 2008a; Hansen et al., 2008b; Jensen et al., 2014).

experience, while the second question examines whether potential biological measures of stress chronicity assess actual prolonged acute stress, i.e., if they correlate with averaged acute stress. To answer the first question, cortisol release fluctuates with induced changes in affect (Buchanan et al., 1999), but the relation between biologically measured and self-reported acute stress is characterized by heterogeneous results (for instance, Buchanan et al. 1999; Hellhammer and Schubert, 2012; Hjortskov et al., 2004; Vinkers et al., 2013; von Dawans et al., 2012). This might be motivated by the time-lag between endocrine responses and psychological responses to stress, the former occurring later (Schlotz et al., 2008). For the relation between self-reported chronic stress and biological measures of chronic stress the jury is still out, since there is no golden-standard for quantifying chronic stress. However, lately, most research in the field has concentrated on the novel, promising measurement of cortisol in hair.

Hair cortisol concentration (HCC) is a new, intraindividually stable measure of chronic HPA axis activity that can provide a monthly calendar of cortisol exposure[12] (Meyer and Novak, 2012; Russell et al., 2012; Stalder and Kirschbaum, 2012a; Stalder et al., 2012b). While possibly affected by hair-washing frequency (Hamel et al., 2011) but robust to hair-coloring, smoking, and oral contraceptive use (Dettenborn et al., 2012a), HCC varies across body regions, with diurnal change, with reactivity to environmental stressors, with gender (men have higher levels, cf. Dettenborn et al., 2012a), and shows localization effects (Sharpley et al., 2012). Nonetheless, research has reliably reported increased HCC in athletes, pregnant women, unemployed individuals, stressed neonates, individuals suffering from chronic pain, as well as people working in shifts, having been through major life events, or having some mental disorders (D'Anna-Hernandez et al., 2011; Gerber et al., 2012; Kirschbaum et al., 2009; Staufenbiel et al., 2013).

Despite its potentiality, hair cortisol concentrations are not generally correlated with perceived chronic stress[13] (Dowlati et al., 2010; Karlen et al., 2011; Stalder et al., 2012c; van Holland et al., 2012), but with major life events, proneness to psychological disease (Karlen et al., 2011), depression (Dettenborn et al., 2012b), increased cardiovascular risk and increased risk of type 2 diabetes mellitus (Manenschijn et al., 2013), BMI (Stalder et al., 2012c), and with caregiving burden and depressiveness in dementia caregivers (Stalder et al., 2014). As an exception, there

[12] The average hair growth rate is 1 cm/ month, so in each 1-cm segment of hair there is information about monthly exposure, with the closest cm to the scalp encompassing the latest month, the second closest the second latest month, and so on. For a thorough state-of-the-art review and detailed explanations see Stalder and Kirschbaum (2012a).

[13] Except for one reported association to the Social Overload Scale of the Trier Inventory for the Assessment of Chronic Stress (Stalder et al., 2012c).

seems to exist an association between perceived chronic stress and HCC in special subpopulations like unemployed individuals (Dettenborn et al., 2010), pregnant women (Kalra et al., 2007), cocaine users (Grassi-Oliveira, 2012), or, if detectable in a subsample of the general population, this association is mediated by ethnic identity and socioeconomic status (O´Brien et al., 2013).

The second question surrounding the various measures of stress refers to whether chronic cortisol exposure measures like HCC assess stress chronicity, i.e., if they are associated to averaged acute stress over a longer period. The answer seems to be positive (van Holland et al., 2012), as some report general significant correlations between HCC and average blood cortisol (Xie et al., 2011), while others confirm it with HCC and salivary cortisol in specific samples like pregnant women (D'Anna-Hernandez et al., 2011). Notwithstanding, it appears that this correlation does not maintain ad infinitum a positive trend, as an initial high cortisol reactivity (and correlated HCC levels), when prolonged, might exhaust the physiological systems and later result in hypoactivation (Kudielka et al., 2006). In fact, a recent report on hair cortisol and perceived stress and health questionnaires shows that this might be the case. Greek youth, who have been subject to multiple, prolonged acute stressors owing to major national economic difficulties, report higher perceived stress, more depressive symptoms, more anxiety, and more major life events, while having lower cortisol levels in hair than equivalent Swedes (Faresjö et al., 2013).

It is not only the development of biological markers for chronic stress and the establishment of hypocortisolism or hypercortisolism patterns under chronic stress that received less attention than acute stress in the field, but also basic research concerning how chronic stress affects cognition, decision-making, and thus behavior. In terms of altered cognition, it has been suggested that acute stress negatively affects reaction times, feedback learning and learning from negative outcomes, working memory and encoding, as well as retrieval and memory for socially important information (Buchanan et al., 2006; Buchanan and Tranel, 2008; Kuhlmann et al., 2005; Petzold et al., 2010; Preston et al., 2007; Putman et al., 2004; Roelofs et al., 2005; Schoofs et al., 2008; Smeets et al., 2008; Takahashi et al., 2004; but see also Soravia et al., 2006), while attention tunneling might enable beneficial effects, facilitating the disregard of peripheral information (Staal, 2004). Yet, if we return to chronic stress, the way it affects cognitive mechanisms is less researched experimentally and current conclusions are based on limited evidence.

Initial proposals assert that chronic stress generally affects performance in individuals with high stress sensitivity (Baradell and Klein, 1993) and adversely impacts neurological structures

involved in learning, memory and decision-making (Lupien and Lepage, 2001; Lupien and McEwen, 1997), disrupting, among others, excitatory working memory networks (Hains et al., 2009). While it seems to have no effect on reaction times (Schwabe et al., 2008), chronic stress appears to affect learning and memory similarly to acute stress (Schwabe et al., 2010), targeting the quality of learning: stimulus-response learning strategies, i.e., habit learning, are used instead of more flexible strategies (Schwabe et al., 2008). Also, short-term memory processing is slower (Brand et al., 2000) and long-term memory is probably affected because of specific decrease of grey matter volume in the hippocampus (Gianaros et al., 2007). Finally, a process that might be heightened, but not beneficial, is the memory for fear-arousing events. Chronic stress seems to improve it and thus lead to a higher sensitivity for negative experiences, a propensity to see risks and threats where none exist, and to experience depression and learnt helplessness (Conrad et al., 1999; Kademian et al. 2004; Korte, 2001; Luethi et al., 2008; Sapolsky, 2000). This last piece of evidence is highly relevant for the present study, where we explore decision-making under chronic stress in contexts of uncertainty. One could already, based on the above evidence, propose that chronic stress would foster risk aversion[14].

However, this hypothesis cannot be settled yet, since it has been both confirmed and rejected before. The only existing study on chronic cortisol exposure and decision-making[15] showed that cortisol administration increased risk aversion (Kandasamy et al., 2014), while a handful of studies on decision-making under acute stress report increased risk loving behavior. Kandasamy et al. (2014) administered hydrocortisone (pharmaceutical cortisol) in a placebo-controlled, double-blind study to 36 participants of both genders over 8 days. They then asked participants to complete several tasks assessing risk preferences and discovered that while acute cortisol increase has no effect on risk aversion, chronic cortisol exposure increases risk aversion independent of gender. While we cannot equate chronic cortisol exposure to chronic stress[16], this evidence should not be ignored.

On the other hand, it has been shown that biologically assessed acute stress affects decision-making under uncertainty (Buckert et al., 2014; Starcke and Brand, 2012). Possibly in a time-dependent manner (Pabst et al., 2013c), risk-taking increases under acute stress (Lighthall et al., 2009; Pabst et al., 2013a; Preston et al., 2007; Starcke et al., 2008; van den Bos et al., 2009). There

[14] Risk aversion translates in behavior by avoiding risk, i.e., choosing less risky options as compared to options offering certainty.
[15] But see also Ceccato et al. (2014) for social decision-making where chronic stress affects women´s transfers in a Dictator Game.
[16] See the results on the association between the two.

is also counterevidence (Gathmann et al., 2014), but this heterogeneity in results is, as detailed in Buckert et al. (2014), due to the heterogeneity in stressors and design-relevant factors like the decision domains or the different ways of varying probabilities and reward values in the tasks. For instance, the decision-making domain seems to yield differential effects under stress (for further explanations see Buckert et al., 2014). A prominent theory in behavioral economics defines that, independent of any emotional state, individuals are generally risk averse for gains, while risk loving for losses (Kahneman and Tversky, 1979)[17]. Acute stress seems to potentiate this natural predisposition, mainly in the gain domain: risk-taking decreases (Buckert et al., 2014; Porcelli and Delgado, 2009), but others report no effect (Pabst et al., 2013b).

Acute stress seems to potentiate yet another natural tendency: gender differences in risk attitudes. While most people are generally risk averse and their risk attitudes are unstable (Bernoulli, 1954; Coates and Herbert, 2008; Guiso et al., 2013), women are more risk averse than men (Eckel and Grosssman, 2008). Under acute stress, these general tendencies are enhanced: risk aversion increases in women and risk seeking increases in men (Preston et al., 2007; Lighthall et al., 2009). However, these differential effects disappear for very high cortisol levels (van den Bos et al., 2009) or are not sustained by data at all (Starcke et al., 2008; Pabst et al., 2013a, b). Again, these mixed results are explainable by design and stressor heterogeneity (see Buckert et al., 2014).

Considering all this evidence, we implemented our aim of exploring decision-making under chronic stress and chronic cortisol exposure in uncertainty conditions in the standard risk-taking paradigm employed in stress research and behavioral economics. However, we had to take into account more than gender-modulated stress effects on risk aversion and encompass in the hypotheses another important gender difference. The only reliable way to measure chronic stress appears to be the use of self-reports and these further differ between genders, with women reporting more psychological distress compared to men, even if these accounts rarely parallel physiological processes (Frankenhäuser et al., 1976; Collins and Frankenhäuser, 1978; Matud, 2004; Schlotz et al., 2011). We thus defined three testable hypotheses below.

[17] Prospect Theory explains that when dealing with possible gains individuals prefer fixed amounts instead of risky gambles, even if the risky gamble offers a higher, mathematically expected reward (see the Experimental Design section for an actual example). Instead, when dealing with potential losses, individuals prefer to gamble, hoping they will decrease their debt, than having to pay a fixed amount. In sum, risk is more attractive when potential losses are involved than when potential gains are in perspective.

3 Hypotheses

Hypothesis 1 Despite mixed results concerning the direction, initial findings seem to indicate that acute stress affects risk-taking. Given that chronic stress presupposes prolonged or multiple exposures to acute stressors, we expect that also chronic stress is related to risk-taking. And, since ambiguity pertains to the domain of uncertainty, we expect, in addition, that chronic stress is associated to ambiguity-taking, too.

Hypothesis 2 A carefully controlled recent study showed that chronic cortisol administration decreases risk-taking, i.e., increases risk aversion. We expect that chronic cortisol exposure, as measured in hair samples, will also positively relate to risk aversion (and ambiguity aversion).

Hypothesis 3 When assessing past experience and affect, women report higher levels of distress and specific symptoms than men. We expect to replicate this finding in the self-report chronic stress measure we use (the Trier Inventory for the Assessment of Chronic Stress, TICS).

4 Experimental Design

4.1 The task

We measured financial risk-taking behavior in the gain domain in a pen-and-paper incentivized task, which we followed up with a spontaneous, real investment decision (more details in the Procedure) and a question exploring self-reported general risk-taking. The risk-taking task followed, for comparability, a standard paradigm and consisted of 25 binary choices between a safe lottery[18] offering 2.25 € and a risky lottery, a supplement of 5 binary choices between the same safe lottery and an ambiguous lottery, as well as 3 control trials proposing choices between the safe lottery and another safe lottery offering a higher amount. The task follows the design used in Buckert et al. (2014) and Hayden et al. (2010). Each of the 33 choices was randomly displayed on a separate page. On each of the 33 task pages participants saw two options simultaneously (Figure 1) and circled the one they chose. For instance, in the upper leftmost pictogram of Figure 1,

[18] We use the term "lottery" interchangeable with the term "gamble" and we refer to situations where outcome success is governed by chance; in this case, the payoff is determined by blindly drawing a colored ball out of a container with two differently colored balls. In the present case the lottery´s probabilities are graphically depicted by colored segments composing a bar and directly presented as mathematical proportions of certain-colored balls out of the constant total of 100 balls (Figure 1).

participants would choose between option A yielding 2.50 € with probability 10% (10 out of 100 balls are yellow) and 0 € with probability 90% (90 out of 100 balls are green), and option B where one would get 2.25 € for sure (100 out of 100 balls are blue). In this case, the expected value[19] of the lottery depicted by option A is much smaller than that of B (0.25 € versus 2.25 €), so the rational choice would be option B.

All three types of trials are depicted in Figure 1 and details regarding the options are presented in Table 1. The 25 trials involving risk combined five reward values, from 2.50 € to 22.50 €, and five wining probability levels, from 10% to 90%, exploring a wide range of risky decisions (see Table 1). Given that the alternative option for these risky option was always a safe option offering 2.25 €, the combinations of value and probabilities yielded ten lotteries where the expected value was smaller than what the safe one offered, five trials with equal expected value to that of the safe alternative, and ten trials with a higher expected value than that of the safe one. The 5 ambiguity trials were meant to pilot the task for higher uncertainty levels.

All lotteries coded their specific uncertainty level through colored bar segments[20] composing the bar, as in Buckert et al. (2014), Hayden et al. (2010), and Putman et al. (2010), and they actually existed in the form of bags containing colored balls in various proportions (photos attached in the Appendix). Participants were shown the bags with colored balls and were assured that the task is real, even if they used pen-an-paper means to express and record their choices. The potential reward of each option was written, in the corresponding color, above and under the bar for lotteries containing two types of balls, and either above or under the bar for safe lotteries containing one type of balls only. A safe choice was represented by an option where all 100 balls were of the same color (Figure 1, choice B in the first pictogram). A random draw would always result in the same colored ball, i.e., a blue ball, and would thus always yield 2.25 €. A risky choice, on the other hand, was represented by an option where a draw would result in one of two differently colored balls (Figure 1, choice A in the first pictogram), i.e., either a yellow ball or a green ball, and would yield either 0 € or 2.50 €. An ambiguous choice was represented by an option where a draw could

[19] The expected value or expected return is the mathematical value of an uncertain event. It is computed by multiplying the possible outcome (a positive reward in our case) by its corresponding probability. For example, in Figure 1, the upper left choice is between a risky option with an expected value of (0.10 x 2.50 €) + (0.90 x 0 €) = 0.25 € (see Table 1, first row, third column) and a safe option with an expected value of 1.00 x 2.25 € = 2.25 €.

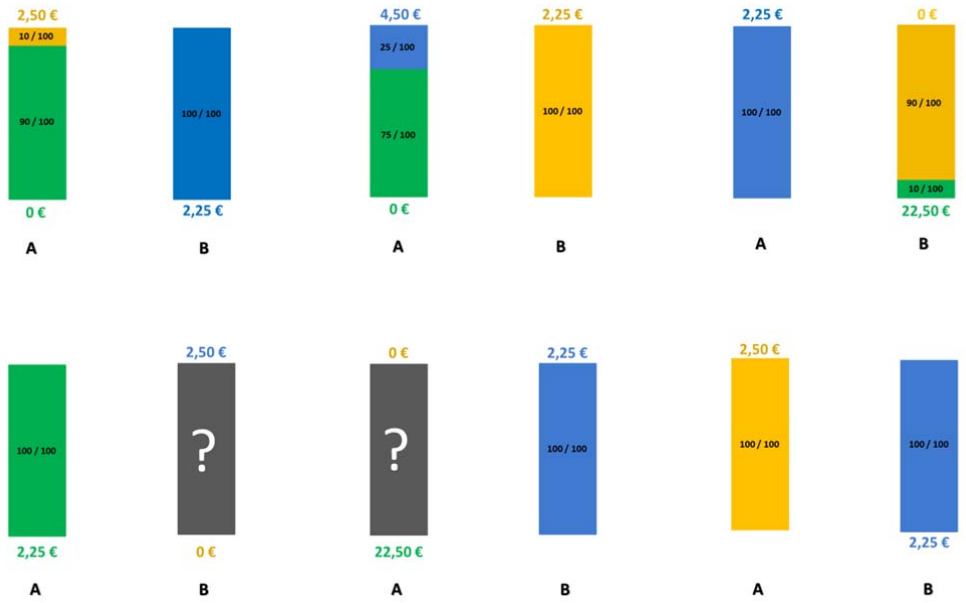
[20] Probabilities for each possible outcome are coded by the color distribution of the bar. The height of the different colored segments signals the proportion of balls of a certain color; the proportion is also written on top of every colored segment. For instance, in the first pictogram of Figure 1 the 10/ 100 proportion is written on top of the yellow segment, explaining that 10 out of 100 balls are yellow.

yield one of two differently colored balls, but the proportion of balls was covered by a grey occluder signed with a question mark (Figure 1, first pictogram in second row, choice A). A draw would result in one of two colored balls, i.e., either a yellow ball or a blue ball, and would yield either 0 € or 2.50 €. However, the chance of drawing a certain color was unknown because the exact distribution of balls could not be seen. Finally, three control trials were introduced to make sure participants understood the task and are not providing automatic or naïve responses by, for instance, choosing always option A, indifferent of the reward they could get or the number of balls associated with a particular reward. A control trial consisted of a binary choice between two safe alternatives, i.e., both containing 100 same-colored balls. A draw from any of these two alternatives would always yield the same payoff, since all balls were of the same color in both options (Figure 1, last pictogram). However, each of the two options in the control trials offered a different reward: one always offered the 2.25 € and it was the same safe alternative from the risk and ambiguity trials, while the other offered a higher amount (see Table 1, last row).

In all three types of trials, risky, ambiguous or control, all factors were randomized: the color of the balls yielding the non-zero uncertain amount (blue, green, or yellow), the color of the balls yielding the alternative zero amount (blue, green, or yellow), the color of the balls yielding the safe amount (blue, green, or yellow), the position of the safe alternative (left or right side of the screen), the position of the uncertain or control alternative (left or right side of the screen), the position of the safe amount (above or below bar), the position of the zero and non-zero uncertain amounts (above or below the bar). Also, there was no feedback for the decisions and no time limit for completing the task.

In order to analyze the data from this task, we quantified risk-taking into a metric variable ranging from 0 to 25. This represents the frequency of choosing the risky option in the 25 binary choices representing risk-taking (rows 1-5 in Table 1). Ambiguity-taking was quantified into a different metric variable ranging from 0 to 5 and it represents the frequency of choosing the ambiguous option in the 5 binary choices measuring ambiguity-taking (row 6 in Table 1). Finally, task understanding was measured with a metric variable ranging from 0 to 3. It encodes the frequency of choosing the safe option with the highest payment.

Figure 1: Example of Task Trials



Note: Six sample pages from the task. First row: Examples of trials involving risky choices. Colored segments indicate the proportion of differently-colored balls. Winnable amounts are written in the corresponding color and the proportion of balls is written on each related colored segment. It is also indicated by the height of the colored segment. Second row: Two examples of ambiguity trials and one example of a control trial (last pictogram).

Table 1: Description of Task Trials

Type of trial	Probability of receiving the non-zero amount	Non-zero amount receivable upon choosing the alternative option				
		2.50 € (+11.11%)	3.00 € (33.33%)	4.50 € (+100%)	9.00 € (+300%)	22.50 € (+900%)
Risk	10 %	0.25 €	0.30 €	0.45 €	0.90 €	2.25 €
Risk	25 %	0.63 €	0.75 €	1.13 €	2.25 €	5.63 €
Risk	50 %	1.25 €	1.50 €	2.25 €	4.50 €	11.25 €
Risk	75 %	1.88 €	2.25 €	3.38 €	6.75 €	16.88 €
Risk	90 %	2.25 €	2.70 €	4.05 €	8.10 €	20.25 €
Ambiguity	? (50 %)	1.25 €	1.50 €	2.25 €	4.50 €	11.25 €
Control	100 %	2.50 €	3.00 €	4.50 €	-	-

Note: The cells in columns 3-7 display the expected values of the 33 randomly played task trials. Choices are always made between a safe option yielding 2.25 € and a risky, ambiguous, or control option. The first five rows (columns 3-7) display the expected values of the 25 risky options, with expected values equal to the safe choice on the bottom-left to top-right diagonal. Row six (columns 3-7) shows the expected values of the five ambiguous alternatives, where the rationally presumed probability distribution is 50% for each of the two colored ball types. The last row (columns 3-7) presents the expected value of the three control trials.

4.2 Procedure

The experiment was conducted at the University of Heidelberg, Germany, and participants were recruited either during coursework and completed the experiment in class, or through the ORSEE pool (Greiner, 2004) and completed the experiment in the laboratory. In class, participants were seated in every other seat for privacy reasons, while in the laboratory they were seated in private cubicles. All their information, responses and choices remained anonymous. The experiment debuted with reading the instructions aloud, so that participants would understand that everybody else was accomplishing the same task (instructions are attached in the Appendix). While describing the options, the research assistants showed the actual bags containing the colored balls (photos in the Appendix) and explained that the payment of each participant will be decided, at the end, by herself/ himself, through drawing a ball out of the corresponding bag. Further, participants were told that they would also determine, by drawing one code out of the 33 possible, which of the trials will be played, i.e., for which specific probability distribution they have to draw a ball from the corresponding bag. In this way, both randomness and trust were assured. Finally, participants were also introduced to the possibility of donating, at the end of the study, a hair sample.

After the participants completed the task and the demographic and psychometric questionnaires, they went to the payment table, one by one, and their final payoff was determined. First, they drew, from a bag containing codes for all the 33 trials they responded to (photo in the Appendix), which of the trials they should play. After the trial was chosen, a research assistant checked which option the participant chose for that respective trial, i.e., the safe option or the alternative one. If the safe option was chosen, the participant was paid the 2.25 € corresponding to it, together with the fixed 3 € participation fee. If the participant had chosen the alternative option, the research assistant paid the safe amount if it was one of the control trials or selected the corresponding bag and gave the participant the opportunity to blindly draw a ball from the respective risky or ambiguous container. The color of the drawn ball decided then the final payoff, which was paid to the participant along with the fixed 3 € participation fee.

Finally, after receiving the payment and privately signing the receipt, the participant was asked to invest the amount he/ she just gained, partly or in total, in a gamble that offered the chance of doubling the investment. This new lottery was constructed as a real-world risk-taking task where money one has consumed time and invested effort for is at stake. Compared to the risk-taking task above, where one could argue that participants were gambling with potential money, in the

investment task participants had to use actually owned money. However, the advantage of the measure derived from the experimental task is that it averages over a wide array of winning probabilities and values. It is thus a better estimation of real-world behavior where decisions under uncertainty occur in various conditions. The outcome of the investment was decided by a coin flip. The participant himself/ herself threw the coin and had a 50% chance of doubling the invested amount and a 50% chance of losing it entirely. We measured this with a metric variable showing the proportion of the payoff that the participant invested (from 0% to 100%). After deciding on the investment task, he/ she either left, if the invested amount was null, or threw the coin and either received double the gambled amount, or received nothing, if the invested amount was non-null.

4.3 Participants

The total sample included 205 young adults who participated in the study either in class (N = 67) or in the laboratory (N = 128)[21]. The sample used for analysis included only 195 observations, as nine participants were excluded because of taking prescription medication for psychiatric conditions and one participant was excluded because of participating for a second time in the experiment. Only 51 of the 195 participants donated hair for cortisol analysis, making the self-reported stress and biological stress samples incomparable. The mean age of our final sample was 22.74 years and ranged from 18 to 33 years with 56.92% women and 43.07% men.

4.4 Control variables

We aimed to uncover the relationship between perceived chronic stress, chronic cortisol exposure, and risk-taking in the absence of most measurable confounding factors. In order to attain this, we collected demographic and psychometric data, controlling for age, income, expertise in economics, acute stress, anxiety, depression, stress reactivity, medication for chronic disease and oral contraceptives. To measure acute stress we elicited momentary self-reports through a visual analogue scale from 0 to 100 (see Kirschbaum et al., 1999). We are aware of the fact that the correlation between physiological and self-reported measures of acute stress has yielded

[21] There is no significant difference in risk-taking behavior or reported stress levels between class and laboratory participants ($p = .17$; $p = .37$)

heterogeneous results (for instance, Vinkers et al., 2013; but also Buchanan et al. 1999; Hellhammer and Schubert 2012; von Dawans et al., 2012), but, in the absence of momentary biological measures, it encodes some degree of emotional activation. To screen for depression and anxiety, both possible consequences of chronic stress and conditions interfering with the cortisol mechanism of stress (Dettenborn et al., 2012b; O'Donovan et al., 2010), we used the validated German version of the HADS- the Hospital Anxiety and Depression Scale (Herrmann-Lingen et al., 2011). Finally, we included, as a brief measure of stress reactivity, the short five-item version of the PSRS, the Perceived Stress Reactivity Scale (Schlotz et al., 2011).

4.5 The chronic stress measure

We measured self-reported chronic stress with the validated German TICS questionnaire. The Trier Inventory for the Assessment of Chronic Stress (Schulz and Schlotz, 1999; Schulz et al., 2004) yields subjective reports of the experiences individuals have had in the last three months. 57 items on a 5-point Likert scale ("never", "infrequent", "sometimes", "frequent", "and very frequent") evaluate chronic stress through nine subscales: "excessive workload", "excessive social demand", "pressure to be successful", "dissatisfaction at work", "mental overload at work", "lack of social recognition", "social tensions", "social isolation" and "chronic anxiety". The TICS can be completed in 10-15 minutes (Schwabe et al., 2008).

We followed to assess naturally-occurring levels of chronic stress towards the end of the winter semester, in November - December 2012 and January - February 2013. This period includes handing in final reports and projects, the winter holidays, exam preparation and exam taking and should therefore provide us with variance with respect to chronic stress. As the span of the stressful period is rather short for each individual student, we modified the original TICS questionnaire and assessed experience pertaining to the last month, instead of the last three months. The inter-item reliability analysis showed that our modification is valid, as the version we employed is as reliable as the original version[22]. To avoid multiple testing and maintain the standard we used in another study (Ceccato et al., 2015), we followed the TICS scoring procedure from Schwabe and colleagues (Schwabe et al., 2008): we summed up a total chronic stress score by adding the 57 items into a continuous variable.

[22] Inter-item reliability analysis for the modified TICS and descriptives are included in Tables 6 and 7 in the Appendix.

4.6 The hair cortisol measure

We collected hair samples from voluntary participants as described in Kirschbaum et al. (2009) and as instructed on the webpage of the Biopsychology Laboratory, Dresden University[23], where samples were then analyzed. We used fine scissors to cut two hair strands from two sites in a posterior vertex position, as close as possible to the scalp. Since we modified the perceived chronic stress questionnaire to reflect the participant´s experience in the latest month, we collected samples of minimum 1-cm segments closest to the scalp and we ordered analyses for this proximal segment. The average weight per hair segment was 7.5 mg ± 0.5 mg. We additionally collected relevant data in connection to the hair samples: the number of washes/ week, hair treatments and natural hair color. Both the hair data and the task were marked with the same unique code that the participant composed according to an algorithm (instructions on code composition are in the Appendix).

4.7 Statistical analysis

We analyzed the data using SPSS version 20 with two-tailed tests for the undirected hypotheses and one-tailed tests for the directed hypotheses. The significance threshold was set at $p < .05$. Behavior was analyzed by performing appropriate correlations between variables denoting chronic stress or chronic cortisol exposure and risk-taking, ambiguity-taking and risky investment. To test the hypotheses that required mean comparisons we used either t-tests or Mann-Whitney U tests, in function of data normality. Finally, we assessed the robustness of the results in an OLS regression model controlling for all measured confounding variables.

5 Results

5.1 Chronic stress is positively associated with risk-taking

We begin by testing Hypothesis 1 and exploring whether chronic stress, measured by the TICS, is associated with choices in uncertain contexts. Table 2 presents descriptive statistics for the main variables in our study and, due to previously reported gender differences, the values are

[23] http://p113367.typo3server.info/index.php?id=183&L=1

calculated for both the overall sample and for each gender separately. Further, Table 3 includes the correlational results for the tested associations. To assess behavior under uncertainty we used the propensity to choose risky gambles in the task, but we supplement our conclusion with results from self-reported risk-taking, ambiguity-taking in the task, and participants' investment in a real gamble. The propensity to choose risky gambles in the task was calculated as the frequency of choosing the risky lottery in the 25 risky trials. On average, participants chose 10.07 risky lotteries out of 25 possible. Exactly 10 lotteries were offering a higher expected value than the 2.25 € safe alternative. We partly accept Hypothesis 1, since there is a significant positive correlation between risk-taking in the task and the TICS score ($r = .18^*$; $p = .011$) (see Table 3).

Self-reported risk-taking was measured through a visual analogue scale from 0 to 10, where participants pinpointed their general willingness to take risks. This measure has been previously validated as a good approximation of real-world behavior under risk (Dohmen et al., 2011) and, even if hypothetical, it is a convenient and fast alternative to risk-taking tasks. We can confirm the validity of this self-report: participants declared that their average risk attitude is situated in-between extreme risk lovingness and extreme risk aversion (5.17 on the 0 to 10 scale), which approximates well their behavior in the task, where they took risks 40% of the time (the correlation between the two yields $r = .35$; $p < .001$). However, overall, self-reported risk-taking is not significantly related to perceived chronic stress, even though the trend shows the same direction as that specified in Hypothesis 1. But women's self-reports correlate positively with perceived stress levels ($r_s = .25$; $p = .024$).

As a different proxy for behavior under uncertainty, the propensity to choose ambiguous gambles was measured in the task[24] by the frequency of choosing the ambiguous lottery in the 5 ambiguity trials. On average, participants chose 1.42 ambiguous lotteries out of 5 possible (28%), less than the proportion of risky choices. Again, this measure is not significantly associated with stress levels overall. However, the positive association trend set by risky choices is confirmed and women´s stress levels are significantly related to choices under ambiguity ($r_s = .23$; $p = .039$).

Finally, we asked participants to invest, if wanted, their recent payoff from the experiment in a spontaneous gamble where a coin throw would determine if the invested amount would double or vanish. The proportion invested correlates significantly with both task-measured risk-taking and self-reported risk-taking ($r_s = .25$; $p = .001$; $r_s = .22$; $p = .003$), but is not related to chronic stress

[24] To pilot a future study, thus the limited number of choices covering a discrete interval of ambiguity.

levels (r_s = .01; p = .905). In sum, we confirm that self-reported chronic stress is significantly and positively associated with risk-taking measured by an incentive compatible task, while decisions under ambiguity are only significantly associated with stress levels for women.

Table 2: Descriptive Statistics for the Main Variables

Variable	Overall	Women	Men
N	195	84	111
Age - M (Me; SD)	22.74 (22.00; 2.46)	22.46 (22.00; 2.07)	22.95 (22.00; 2.71)
% Females - fq	43.07%	100%	0%
HCC (pg/mg) - M (Me), (SD) N	7.04 (5.91) (3.60) 51	6.26 (4.41) (3.75) 21	7.59 (7.12) (3.45) 30
TICS - M (Me; SD)	83.50 (84.00; 26.03)	87.43 (85.50; 24.71)	80.52 (80.00; 26.71)
Risk-taking frequency (task) - M (Me; SD)	10.07 (10.00; 3.47)	8.80 (9.00; 3.30)	11.04 (10.00; 3.29)
Risk-taking (self-report) - M (Me; SD)	5.17 (5.00; 1.92)	4.79 (5.00; 1.93)	5.45 (6.00; 1.87)
Ambiguity-taking frequency (task) - M (Me; SD)	1.42 (1.00; 1.43)	1.19 (1.00; 1.10)	1.59 (2.00; 1.16)
Investment % - M (Me; SD)	36.34% (30.00; 39.21)	23.92% (10.00; 30.90)	45.77% (45.00; 42.26)

Note: The table displays descriptive statistics for the main variables. Statistical measures are denoted by symbols: “M” for “mean”, “Me” for “median”, “SD” for “standard deviation”, “fq” for “frequency” and “N” for “sample size”.

Table 3: Correlations

		Stress variable	Coefficient (r or r_s)	Overall r/ r_s (p) N	Females r/ r_s (p) N	Males r/ r_s (p) N
Behavioral variable	Risk-taking frequency (task)	TICS	r	.18*(.011) 195	.29** (.007) 84	.20* (.035) 111
	Risk-taking (self-report)		r_s	.10 (.188) 195	.25* (.024) 84	.07 (.499) 111
	Investment %		r_s	.01 (.905) 183	-.06 (.624) 79	.09 (.377) 104
	Ambiguity-taking frequency (task)		r_s	.09 (.238) 195	.23* (.039) 84	.03 (.778) 111
Stress variable	Risk-taking frequency (task)	HCC (pg/mg)	r_s	.15 (.141) 51	.18 (.221) 21	-.02 (.461) 30
	Risk-taking (self-report)		r_s	.14 (.158) 51	.07 (.380) 21	.04 (.408) 30
	Investment %		r_s	.21 (.081) 47	.03 (.452) 20	$.31^{+}$ (.060) 27
	Ambiguity-taking frequency (task)		r_s	.10 (.238) 51	.04 (.4398) 21	.04 (.4097) 30
	TICS		r_s	-.16 (.260) 51	-.18 (.437) 21	-.14 (.459) 30

Note: The table displays appropriate correlation coefficients for either Pearson (r) or Spearman (r_s) tests, as well as the sample size for each correlation analysis (second line, under the parentheses, denoted by N). Correlations significant at the .05 level are denoted by "*" and those significant at the.01 level by "**".

5.2 Chronic cortisol exposure is not associated with risk-taking or perceived chronic stress

We measured chronic cortisol exposure by analyzing cortisol concentrations in hair samples. Unfortunately, just 26% of our participants (N = 51) agreed to donate hair samples, and this low rate was similar for both genders: 27% of the male participants (N = 30) and 25% of the female participants (N = 21). As such, the predictive power of the analysis considering cortisol exposure is much lower than the results we uncovered on self-reported chronic stress and behavior. Further information concerning the hair samples and cortisol concentrations is included in the Appendix. This biological facet of stress is not significantly related to any of the variables measuring decision-making under risk in our study (see Table 3), but shows a positive association at trend level with the investment in the gamble for men ($r_s = .31$; $p = .060$). We therefore cannot confirm Hypothesis 2.

A further analysis that can supplement research in the field is the correlation between chronic cortisol exposure and perceived chronic stress. In our data there is no significant association between the two, but it should be noted that the relation is negative. We reconfirm this lack of a significant correlation with supplementary data from an unrelated experiment. In December 2013 48 participants gave hair samples for analysis and completed the Perceived Stress Scale (PSS, Cohen et al., 1983) at the economics experimental laboratory of Pompeu Fabra University, Barcelona, Spain. Data from 21 males and 27 females shows, again, that there is no significant association between chronic cortisol exposure and perceived stress ($r_s = .21$; $p = .152$). However, the relation appears positive in this data set.

5.3 At trend levels, women report higher TICS levels than men

Gender differences in stress self-reports have been often outlined in the literature. We replicate this, at trend level, but cannot confirm Hypothesis 3 because of the lack of statistical significance (see Table 4). Women report, on average, a score of 87.43 (Me = 85.50) on the TICS, while men report almost 10% less, 80.52 (Me = 80.00). Mean levels are presented in Table 2 and mean comparisons in Table 4. The difference between these two means is not statistically significant at the threshold we established, but is considerable ($p = .066$; Cohen's $d = -0.27$). If we look at the biological facet of stress, the opposite trend can be observed: men have higher average

hair cortisol concentrations (7.59; Me = 7.12) than women (6.26; Me = 4.41) and this distinction is significant at trend level (p = .075; Cohen's d = 0.370)[25].

However, in what regards self-reports, a significant difference between genders is detectable in the self-reported risk-taking variable, where women situate themselves, on average, at 4.79 (Me = 5.00) on a scale from 0 to 10, while men at 5.45 (Me = 6.00). This notable difference (p = .025; Cohen's d = 0.347) predicts actual behavior under uncertainty, as we discuss below.

Table 4: Mean Comparisons between Genders

	Tested variable					
	TICS	Risk-taking frequency (task)	Risk-taking (self-report)	Investment %	Ambiguity-taking frequency (task)	HCC (pg/mg)
p-value	.066^{+}	<.001****	.025*	.001***	.014*	.075^{+}
Test	t-test	t-test	MW	MW	MW	MW
t(df)/z	-1.846 (193)	4.695 (193)	- 2.239	- 3.314	- 2.455	- 1.780
N (N_f; N_m)	195 (84; 111)	195 (84; 111)	195 (84; 111)	183 (79; 104)	195 (84; 111)	195 (84; 111)

Note: The table displays, for each tested variable, p values, the applied test, the t- or z-value, and the sample size for mean comparisons between gender subsamples. Trends significant at the .10 level are denoted by "$^{+}$", while values significant at the .05 level are denoted by "*", those significant at the .01 level by "**", those significant at the .001 level by "***", and those significant at <.001 level by "****".

5.4 Women take significantly less risk than men

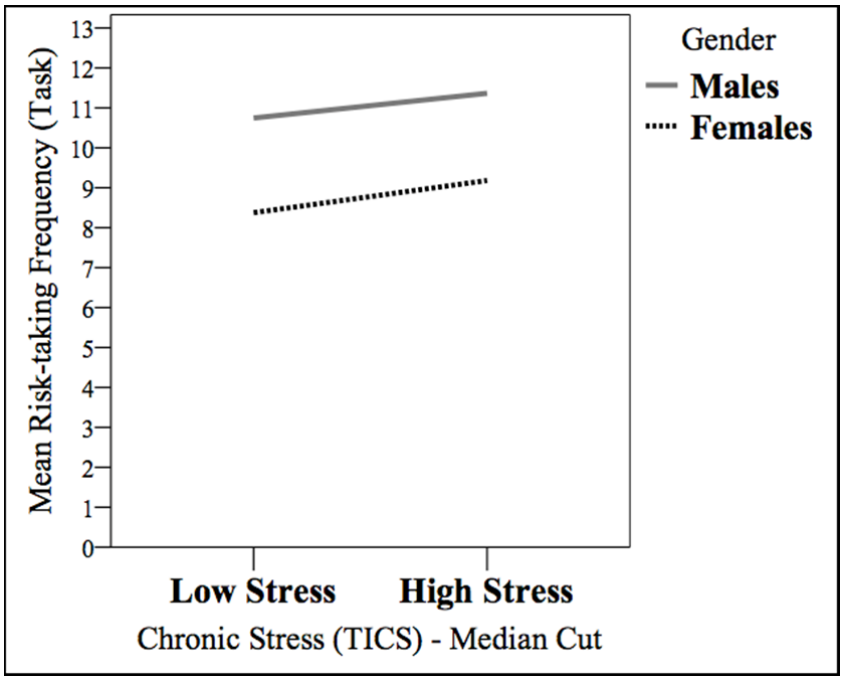
Women reported to take significantly less risks, in general, compared to men. This hypothetical measure is in line with measures of actual behavior. For all three variables assessing real-world financial risk-taking the difference between genders is highly significant. In the main task men choose the risky option 11.04 (Me = 10.00) times out of 25 times, while women 8.80 (Me = 9.00) times (p < .001; Cohen's d = 0.679). Similarly, men chose the ambiguous option 1.59 (Me = 2.00) times out of 5 possible, while women 1.19 (Me = 1.00) times (p = .014; Cohen's d = 0.356). Finally, men invest 45.77% (Me = 45.00%) of their payoff in a gamble, while women only almost

[25] We do not replicate this in the Spanish data (p = .324), where women have higher hair cortisol concentrations than men.

half of that, 23.92% (Me = 10.00%), and this difference is highly significant (p = .001; Cohen's d = 0.590).

The marked difference in behavior under uncertainty, along with the trend difference in the chronic stress measure drive overall gender differences in the correlation between risk-taking and stress. Figure 2 shows, in parallel, the associations between risk-taking in the task and TICS scores for each gender. While chronic stress is positively and significantly associated overall with risk-taking in the task (r = .18; p = .011, Table 3), this association is higher and more significant for women (r = .29; p = .007, Table 3) than for men (r = .20; p = .035, Table 3). For presentation purposes only, we divided the TICS scores at the median and plotted the resulting trends in Figure 2. It is there clearly noticeable how both associations display an increasing trend and how risk-taking levels differ between genders: men take more risk, independent of stress levels. Interestingly, this gender contrast renders associations that were insignificant for the overall sample significant for women. Specifically, self-reported stress levels positively relate also to self-reported risk-taking (r_s = .25; p = .024, Table 3) and ambiguity-taking (r_s = .23; p = .039) for women. For men, neither correlation is significant.

Figure 2: Gender Differences in the Association between Risk-taking (task) and Self-reported Chronic Stress



Result 1 Self-reported chronic stress is positively associated with risk-taking.

Result 2 Chronic cortisol exposure is not associated with risk-taking or perceived chronic stress.

Result 3 At trend levels, women report higher chronic stress levels than men. The gender difference persists also in what concerns risk-taking.

In what follows, we test the robustness of our main contribution in a regression adjusting for possible confounding factors.

5.5 Chronic stress is positively related to risk-taking in young adults

The results of the analyses presented above indicate that, independent of gender, self-reported chronic stress is significantly correlated with financial risk-taking measured in actual behavior with real stakes. We put this association to further test in seven OLS regression models (Table 5), explaining risk-taking frequency in the task by self-reported chronic stress, task understanding, demographic variables and psychometric variables that might interfere with chronic stress.

Inspection of the first line of all seven regression models already shows that, independent of all controls, self-reported chronic stress explains risk-taking significantly and constantly. The coefficients of the TICS variables (both unstandardized and standardized, of course) and the robust standard errors do not change dramatically and maintain stable levels. However, further effects from other variables, e.g., gender, grant a more detailed discussion of these models.

The first model motivates risk-taking by *perceived chronic stress (TICS)* for both genders. The second model details the first one with *gender* (0= Male, 1= Female), while the third includes the interaction between *chronic stress x gender*, and the fourth controls for the effect of task mis/understanding. Model five adds demographic controls: *age*, *income*, and *economics major (0= No, 1= Yes)*, and model six looks in detail at the effect of income in the *gender x income* interaction. Finally, *acute stress (VAS)*, a screening for *anxiety (HADS-A)*, a screening for

depression (HADS-D), *medication for chronic disease (0= No, 1= Yes)*, and a brief measure of *stress reactivity (PSRS-5)* are controlled for in the seventh model.

Based on the regression models, we can confirm the robustness of the main result we presented in the previous subsection: chronic stress is related to risk-taking. Perceived chronic stress, in the first model, has a positive and significant effect on risk-taking. The effect slightly strengthens when gender is introduced in the second model, and the gender's coefficient shows the gender difference in risk-taking we replicated. The third model encompasses an insignificant interaction between chronic stress and gender and thus shows that the difference in the effects between genders is not noteworthy.

Further, the fourth and fifth models reconfirm the robustness of the effect of chronic stress and gender on risk-taking, while flagging a trend-level effect of income, which might positively influence decision-making under risk. To clarify this marginally significant effect, the sixth model includes the interaction between gender and income, which washes out the partial effect of income that arose in the previous model and shows that women are risk-cautious at all income levels. Finally, the last model reaffirms the robust effect of perceived chronic stress on risk-taking, independent of stress reactivity, and excludes confounding effects from related psychological states and conditions.

In brief, the regression models confirm that self-reported chronic stress as measured by the TICS robustly explains risk-taking for both genders, accounting for, but independent of, specific gender differences: chronic stress promotes risk loving behavior in young adults.

Table 5: Regression Analysis

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)
Chronic Stress (TICS)	0.026*	0.031**	0.026*	0.026*	0.026*	0.025*	0.029*
	0.188*	0.222**	0.187*	0.187*	0.190*	0.183*	0.212*
	(0.010)	(0.009)	(0.012)	(0.012)	(0.012)	(0.012)	(0.015)
Gender (0= Male, 1=Female)		- 2.492***	- 3.569*	- 3.562*	- 3.225^{+}	- 5.338*	- 4.624^{+}
		- 0.350***	-0.501*	-0.500*	-0.453^{+}	-0.749*	-0.649^{+}
		(0.485)	(1.695)	(1.702)	(1.712)	(2.336)	(2.405)
Chronic Stress x Gender			0.013	0.013	0.012	0.014	0.010
			0.165	0.164	0.155	0.178	0.127
			(0.019)	(0.019)	(0.020)	(0.020)	(0.020)
Control Task Trials				0.066	0.039	- 0.132	- 0.184
				0.005	0.003	- 0.010	- 0.014
				(0.878)	(0.882)	(0.890)	(0.895)
Age					0.047	0.033	0.015
					0.033	0.023	0.011
					(0.102)	(0.102)	(0.104)
Income					0.759^{+}	0.234	0.240
					0.124^{+}	0.038	0.039
					(0.429)	(0.583)	(0.595)
Economics Major (0 = No, 1 = Yes)					0.580	0.505	0.445
					0.080	0.070	0.061
					(0.511)	(0.513)	(0.518)
Gender x Income						1.148	1.176
						0.283	0.290
						(0.866)	(0.884)
Acute Stress (VAS)							0.016
							0.115
							(0.010)
Anxiety (HADS)							- 0.052
							-0.053
							(0.097)
Depression (HADS)							- 0.050
							-0.043
							(0.105)
Medication for Chronic Disease (0 = No, 1 = Yes)							- 1.009
							- 0.130
							(0.717)
Stress Reactivity (PSRS5)							0.119
							0.067
							(0.144)
Constant	7.931***	8.607***	8.998***	8.800**	5.997	7.904^{+}	7.782^{+}
	(0.863)	(0.820)	(1.011)	(2.836)	(3.868)	(4.120)	(4.185)
N	187	187	187	187	187	187	187

Note: The independent variable is risk-taking frequency in the task. Unstandardized, standardized coefficients (β) and robust standard errors (parentheses) are shown. Significant results have a (+) for trends where $p < .10$, (*) for $p < .05$, (**) for $p < .01$, and (***) for $p < .001$.

6 Discussion

We proposed one of the first studies of decision-making under chronic stress and chronic cortisol exposure, seeking to evaluate if the effects of acute stress on decisions involving uncertainty perpetuate. We employed the Trier Inventory for the Assessment of Chronic Stress (TICS) to measure perceived chronic stress, hair samples to assess chronic cortisol levels, and a standard risk- and ambiguity-taking task, followed by self-reported risk-taking and a gamble with owned money, to evaluate decision-making under uncertainty. While we did not manage to obtain comparable sample sizes for the biological and self-reported facets of stress, hindering the power of our conclusions, we found that perceived chronic stress relates robustly and significantly to financial risk-taking, an appropriate model for real-world risk-taking. Based on our data, out of the four defined hypotheses we can only partially confirm the first and third hypotheses, and reject the second hypothesis.

We first expected, based on the research scrutinizing acute stress effects on decision-making under uncertainty (see Buckert et al., 2014; Starcke and Brand, 2012), that chronic stress will be related to risk- and ambiguity-taking behavior. The most often used model for decision-making under uncertainty in acute stress research is risk-taking, but design details are heterogeneous for different authors and thus yielded mixed results. While most reports delineate an increase in risk-taking under acute stress (for instance, Lighthall et al.; 2009, Pabst et al., 2013a; Starcke et al., 2008), there are some others that report the opposite trend (Gathmann et al., 2014). For this reason, we did not direct the first hypothesis and speculated only on the existence of a significant relationship between the two variables. Further, as most research on acute stress settled on the gain domain, we have only constructed trials in this domain, but we underline the fact that changing the domain, e.g., having participants make choices in the loss domain, might dramatically shift results[26].

We uncovered the fact that perceived chronic stress is significantly and positively related to risk-taking for both genders, but stronger for women than for men. Ambiguity-taking, in contrast, is not related to perceived chronic stress for both genders, but only for women. This gender differences and specificity for ambiguity-taking warrants further discussion. First, it might be partially driven by the underlying gender differences in risk-taking, independent of stress and other

[26] For instance, see the discrepancy between risk aversion for gains and risk lovingness for losses in Kahneman and Tversky (1979).

psychometric and demographic controls (further discussed below). However, the fact that chronic stress is associated stronger to risk-taking for women than for men might indicate that, despite initial higher risk aversion, women are more sensitive to uncertainty cues when under stress. While we do not discuss the rationality or optimality of the decisions, nor we pretend to define the key motivation or mechanism, we advance the idea that, under perceived chronic stress, risk aversion is reduced and this is stronger for women, probably due to increased stress sensitivity. The overall result, however, is in line with the STARS model proposed by Mather and Lighthall (2012), where decision-making is thought to be reward-biased under stress, as stress triggers additional reward salience (STARS). In this sense, it might be that the riskiness of the lottery, i.e., the fact that there is a chance to gain nothing, is underestimated, while the probability to get the higher reward is overestimated.

A last mention that has to be made in discussing the first hypothesis is the fact that ambiguity, in contrast to risk-taking, was measured briefly, in an attempt to offer a general proxy for behavior under higher levels of uncertainty. On one hand, the fact that already with such a crude measure a positive association with chronic stress for women appeared, and in terms of power it almost parallels the association between risky decisions and stress, strengthens the speculation about increased behavioral sensitivity to stress in women. Moreover, this is further confirmed by the significant correlation between self-reported risk and stress, in women only[27]. On the other hand, the limited content of the ambiguity trials might disqualify them as a proper measure of behavior under high uncertainty, and, while this indication that we present warrants further research, the discussion concerning gender differences should occur in the context of an extended task under ambiguity conditions. Moreover, in this respect, one should also note that individuals are generally less likely to gamble under ambiguity than under risk (Camerer and Weber 1992), and risk and ambiguity attitudes might stem from different physiological and psychological processes (Huettel et al., 2006; Levy et al., 2010; Trautmann, 2014).

It is not only self-reported chronic stress that relates to behavior, but its biological counterpart, chronic cortisol exposure, might have discernible effects, too. We have hypothesized this because of the fact that glucocorticoids[28] are known to regulate various cognitive functions

[27] While it remains questionable if the way participants responded to this item, that requested their general willingness to take risks, relates to their "natural" attitude towards risk instead of the temporary change chronic stress might have induced, we expect that their self-reports are influenced by their current state, i.e., if chronically stressed, and that, responding after the task, participants have included the auto-evaluation of their recent behavior under risk in their self-assessment.

[28] Hormonal group where cortisol belongs.

(Cahill and McGaugh, 1996) and because a recent study brings evidence that hydrocortisone administration increases risk aversion, i.e., decrease risk-taking (Kandasamy et al., 2014). The only pharmaceutical study of chronic cortisol exposure and decision-making, the study of Kandasamy et al. (2014) measured financial risk-taking after a 8-day administration of hydrocortisone to voluntary participants. This placebo-controlled, double-blind experiment unveiled that prolonged cortisol exposure increases risk aversion independent of gender. We thus hypothesized that we would see similar associations between hair sampled cortisol and risk-taking. However, we did not find any correlation between chronic cortisol exposure measured in hair samples and financial risk-taking, though a trend-level, positive association between HCC and investment in the gamble surfaced for men. There are two main points worth conferring about when considering our result.

First, chronicity differs between studying an 8-day hydrocortisone administration and analyzing cortisol measured in hair samples. While the first is limited to 8 days, the second evaluates average cortisol release over one month. Second, ad-hoc HCC measurements incorporate all sorts of heterogeneous factors that a standardized hydrocortisone administration might deter from: the individual's "normal" cortisol levels, his/her reactivity to stressors, his/her sensitivity or resistance to the effects of glucocorticoids, and one's own maximal reactivity in conditions of stress. While, when considering all these interindividual factors, also HCC measures might yield standard thresholds for very different persons, its averaging character might yield a different standardization than hydrocortisone dosage. In contrast, if one could possibly account for interindividual variety, pharmaceutical studies would have a better chance of determining precise effects and thresholds than post-hoc measurements like HCC.

There is a further unsettled matter in the literature that we can contribute to with our data. Hair cortisol concentrations have not been reliably correlated with perceived chronic stress (Dowlati et al., 2010; Karlen et al., 2011; Stalder et al., 2012c; van Holland et al., 2012), but with major life events and other conditions and experiences of special populations (e.g., Dettenborn et al., 2010; Dettenborn et al., 2012b; Grassi-Oliveira et al., 2012; Stalder et al., 2014). We also did not find any significant association between the two in any of the data sets we hold, and we discovered a negative relation in this study's data[29]. This last, somewhat surprising finding has been also reported in a recent study showing that chronic stress caused by the economic environment might

[29] Please note that the sample sizes differ between measures and we could only test the association in the 51 participants who both donated hair and completed the TICS. A higher sample size would undoubtfully clarify the relation between HCC and perceived stress, as well as that between HCC and behavior.

cause hypocortisolims (Faresjö et al., 2013). It has also been suggested before and motivated by HPA axis exhaustion (Kudielka et al., 2006).

In what concerns the lack of correlation between HCC and perceived chronic stress, Stalder and Kirschbaum (2012a) highlight the puzzling association of HCC and cortisol with stress-related conditions, but not perceived acute or chronic stress. The authors suggest retrospective bias as a potential cause. Of course, an ambulatory assessment over a long period or a well-thought, ethical intervention study might clarify this phenomenon. Another described cause that might motivate the lack of correlation is the fact that in normal populations stress exposure is insufficiently high in order to produce a physiological response that would further render differences in HCC. We agree that exam stress, on average in a student population, might not be high enough to stimulate a marked chronic cortisol response.

We additionally propose that stress resilience, personal characteristics as trait anxiety or neuroticism, and a potential mismatch in the hair collection procedure might contribute to the lack of correlation between HCC and subjective measures of chronic stress. The hair collection procedure presupposes hair cutting as close as possible to the scalp and is based on the assumption that the closest 1-cm segment to the scalp encloses, on average, cortisol exposure from the most recent month, despite heterogeneity in hair growth rates. While a few millimeters are lost because of cutting instead of, for instance, shaving or plucking, terminal hair, as that on the scalp, extends a few millimeters inside the hypodermis (Wosicka and Cal, 2010). Thus, recently produced hair is uncuttable at the surface and this accounts for an outgrowing lag time of 1-2 weeks (Russell et al., 2012). In sum, the cuttable hair segment at the scalp's surface might account for stress dating more than one month old, even if HCC levels correlate well intraindividually (Stalder et al., 2012b). However, we restate that despite potential problems with using HCC as a biological measure for chronic stress and its lack of connection to subjective stress, behavior in decision-making under uncertainty, especially under risk, is still connected to self-reported stress, but not HCC. It might be that, in lack of actual biological effects, stress changes perception and perspectives, like the general view upon the world and upon uncertainty.

The third hypothesis returned our endeavor to gender differences in behavior and perception. Women are known to report higher psychological distress then men (e.g., Matud, 2004; Schlotz et al., 2011) and, given that we measured chronic stress through self-reports, we expected to replicate this finding. While we did find the direction of these findings to be reliable, we could not

replicate it significantly, but only at trend levels. The fact that women see themselves as subject to higher distress might be explained in several ways. First, given their overlapping social roles, it might indeed be the case that they are exposed to more stressors. Another plausible explanation is the fact that women might have a higher responsivity to stress (Kudielka et al., 2004a), especially young women (Kudielka et al., 2004b), as is the case in our sample. Also, it could well be that women tend to exaggerate their symptoms, resulting in over-reporting distress experience. Finally, it might also be possible that women observe more, analyze more, and thus are more aware of their bodily and mental states, and, in this sense, their reports are closer to objective occurrences around them and inside their bodies.

We can also contribute to the behavioral economics literature: we replicate the general notion that women are more risk averse than men (reviewed in Eckel and Grosssman, 2008) with all four variables that measured behavior under uncertainty in our study: self-reported risk-taking, actual risk-taking in the main task, ambiguity-taking in the main task, and investing in a gamble recently gained money in the experiment. Interestingly, in relation to perceived chronic stress, risk lovingness appears for both genders, instead of risk aversion or gender-specific risk aversion. In what concerns the underlying motivation of this (maybe) evolutionarily-derived difference, we refrain from defining post-hoc explanations. Instead, we direct the reader to Eckel and Grosssman (2008) where experimental conditions are objectively and thoroughly analyzed.

Finally, the present study has several limitations. First, the measures we employed are based on ad-hoc stress levels, without any chronic stress treatment or controlled chronic stress induction, in the experimental sense. Given the naturally occurring stress levels we are basing our analysis on, our results are purely correlational and do not speak of any causal relation between chronic stress and risk-taking. The same limitation applies to our results regarding the relation between perceived stress and cortisol exposure. Furthermore, our results stem from a very peculiar sample and have thus limited generalizability: young, highly educated adults studying or having studied at Heidelberg University or neighboring universities took part in the study. We were suggesting above that personal characteristics could mediate stress reactivity and even the relationship between biological stress levels and perceived stress. This is another group of possible confounding variables we did not control for.

We further lack, as suggested in Trautmann (2014), thorough measures regarding heterogeneity in stress reactivity and sensitivity to stress. As Trautmann (2014) explains,

predictions about behavior under stress become externally valid if they account for susceptibility to stress, which may, in the real world, affect economic preferences and drive self-selection into certain professions, environments and activities. Finally, a justified critique could also target the stakes we propose in the study. While the payoff of the risky/ ambiguous lottery varies to some extent, that of the safe alternative is a constant modest amount. And, even if we used payment levels in agreement to general experimental practices with students and aligned the payoffs to the average student income, it may still not be enough to motivate the revealing of true preferences, and it may even encourage risk seeking behavior.

Nonetheless, we have opened an important avenue in investigating the effects of perceived chronic stress and chronic cortisol exposure on decision-making and future experiments could shed more light on the matter and help derive better measures for the phenomena under discussion.

7 Conclusion

We explored the relation between decision-making under uncertainty and self-reported chronic stress as measured by the Trier Inventory for the Assessment of Chronic Stress. We additionally collected hair samples to integrate chronic cortisol exposure as the biological facet of prolonged stress. Decision-making under uncertainty was primarily assessed through binary choices between safe and risky lotteries, and supplemented with self-reported risk-taking, and an investment of own money in a real gamble. We discovered that there is a significant correlation between chronic stress and actual risk-taking for both genders and this positive relation is robust to multiple demographic and psychometric controls. However, we observed a slight gender difference in this correlation, in that it is stronger for women than for men. Moreover, gender differences persist also in risk-taking, independent of stress, and, at trend level, in self-reported stress and risk-taking measures. In what regards physiological parameters, we found no relation between cortisol exposure and general risk-taking, as well as self-reported chronic stress. However, an interesting trend-level connection arose between HCC and men's investments in the final gamble.

Our study directly contributes to the scarce research on chronic stress and decision-making, and follows up the line of research regarding chronic cortisol exposure and perceived stress levels. Two avenues would greatly improve the state of the knowledge in this field. First, a study performing an ecological assessment of daily stress and chronic cortisol markers would be very

helpful in understanding the relation between the two main stress responses. Second, a higher account for interindividual variability in stress experience and reactivity, together with the mediating effect of personal characteristics, could clarify the heterogeneity of existing reports.

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Appendix

Inter-item reliability analysis and descriptives of TICS scores

Table 6: Inter-item Reliability Analysis for the Original and Modified Versions of the TICS

Scale Label	Number of Items	Cronbach´s Alpha Original Version (Experience in the Last 3 Months)	Cronbach´s Alpha Modified Version (Experience in the Last Month)
ERDR	9	.90	.78
MANG	4	.84	.79
SORG	4	.88	.87
SOUE	6	.84	.78
SOZI	6	.88	.90
SOZS	6	.87	.85
SSCS	12	.91	.87
UEBE	8	.90	.87
UEFO	6	.87	.86
UNZU	8	.85	.81
Average	10	**.87**	**.84**
TICS	57	-	**.94**

Note: Cronbach´s Alpha values for the Original version are taken from the TICS manual (Schulz et al., 2004). The table rows display descriptives and analysis coefficients for the nine facets of stress comprised in nine scales (ERDR, MANG, SORG, SOUE, SOZI, SOZS, UEBE, UEFO, UNZU), a screening scale for chronic stress (SSCS), the average value of inter-item variability and the total TICS score (not existent in the original version). The nine facets of stress code the following content: pressure to be successful (ERDR), lack of social recognition (MANG), chronic anxiety (SORG), excessive social demand (SOUE), social isolation (SOZI), social tensions (SOZS), excessive workload (UEBE), mental overload at work (UEFO), and dissatisfaction at work (UNZU).

Table 7: TICS Descriptives

Sample	N	Mean	Minimum	Maximum	Median	Standard Deviation	25th Percentile	75th Percentile
Pooled	195	83.50	34	171	84.00	29.03	63.00	100.00
Females	84	87.43	37	142	85.50	24.71	70.00	105.50
Males	111	80.52	34	171	80.00	26.71	58.00	100.00

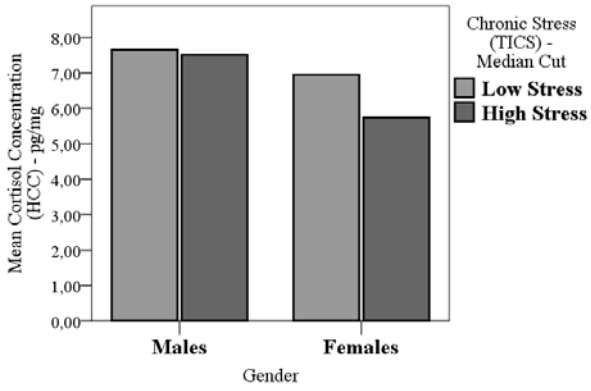
Note: The descriptives are given for the entire sample (second row), for females only (third row), and for males only (fourth row).

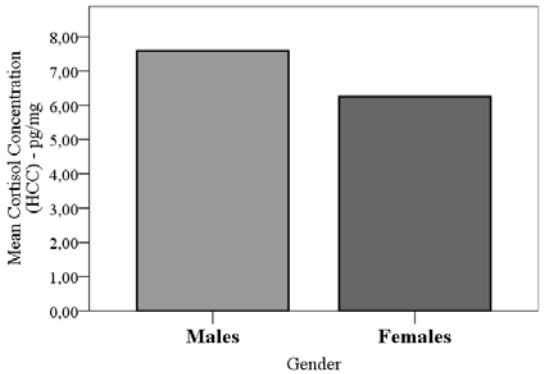
Further details on hair samples and hair cortisol concentrations

Table 8: Hair Cortisol Variables

	Mean	Median	SD	N (%)
Hair Cortisol Concentration (HCC) – pg/mg	7.04	5.91	3.60	51
Hair treatment	-	-	-	6 (11.76%)
Washes per week	5.12	5.00	1.68	51
Blond Hair	-	-	-	20 (39.21%)
Brown Hair	-	-	-	26 (50.98%)
Red Hair	-	-	-	1 (1.96%)
Black Hair	-	-	-	3 (5.88%)

Note: The table displays main statistics for hair cortisol- related variables.





Instructions

(Please do not open the folder in front of you until you are prompted to do so!)

Dear Participant,

Thank you for being part of this study.

Before we begin the study and read the instructions, we would like to draw your attention to something you could do to further support our research. Upon completion of this experiment, you can donate a small hair sample. The amount of hair we need is more or less equal to what you naturally lose in one day and we will be paying 3 euros for your time. We will examine the hair sample for hormone concentrations. Of course, the hair donation is anonymous. If you want to support us, please find us, once the study is finished, in Room 00.012, at the ground floor, in Bergheim campus. At the very end of the task folder in front of you, there is more information concerning the hair donation. You do not have to decide about this now, you can read the info sheet and ask more questions after the study today has finished.

Now we can begin the study and you are allowed to open the folder in front of you. Please do not start to look through the pages.

In front of you there is a folder containing three piles of papers. The top pile contains the task instructions that we will read together, and the instructions to create your personal identification code. The study today is completely anonymous, so from now on you will be identifying yourself only through the identification code you will create. Please, do not write your name on any of the paper sheets in the folder.

The middle pile contains the task that you will have to complete today. Please do not try to look at it before we instruct you to do so. After reading the task instructions and generating your identification code, we will continue with the task.

The last pile contains questionnaires. We ask you to fill these in after you have finished completing the task. While you are completing the questionnaires, one of the research assistants will come to you and determine your payoff from the task.

Creation of personal identification code

Prior to the beginning of the experiment, we kindly ask you to read this page carefully and follow the instructions below in order to create your personal identification code. You will be asked today, at various times points, to enter your personal identification code in order to personalize the task you are accomplishing. It is only with this identification code that we can differentiate between participants, while handling your data anonymously.

Instructions

Please answer the following questions:

Identification Code

The second letter of your mother's first name:

…….. ____

The day of your birthdate (for example: 03)

…….. __ __

The third letter of the street on which you currently live:

…….. ____

The second and third letters of your eye color:

…….. __ __

Your height in centimeters (for example: 174):

…….. __ __ __

Example of personal identification code creation: If your mother would be called Petra, you would have been born on the 3rd of July 1954, you would now live on the Boulevard Street, your eye color would be blue and your height would be 174 cm tall; then your personal identification code would be ***E 03 U LU 174.***

The data collected from you today is, of course, subject to confidentiality. It cannot be disclosed to any third party.

Thank you for your help!

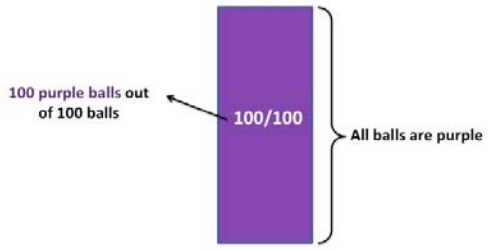
Task Instructions

Thank you for participating in our study today. The duration of this study is approximately 40 minutes. You will receive 3 € for your participation, and will additionally receive a variable amount from the task. Details will follow. However, it is important for you to already know that you have to fill in a receipt for your payoff at the end of the study, so that we can justify proper fund usage.

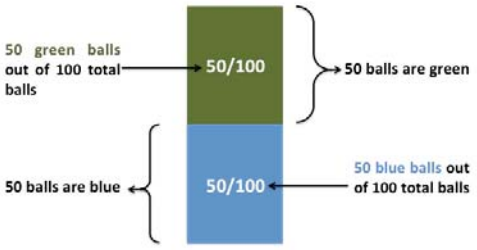
We guarantee complete anonymity of your data at all times; that is, the researchers cannot connect your identity to your choices in the task or your responses to the questionnaires. You will create your own code, which serves as your identification in this study. However, for signing the payment receipt, we need your real name. Therefore, a second researcher who does not supervise your task and questionnaire completion will take care of the payment at the end of the study.

The task that you will complete today consists of 33 choices. Each choice is presented on a separate page. There are a total of 33 pages. Once you have made the decision on a certain page, please pass to the next page. You can **NOT** turn back the pages. If we observe that you turn back the pages, we must ask you to leave and you forgo your payment.

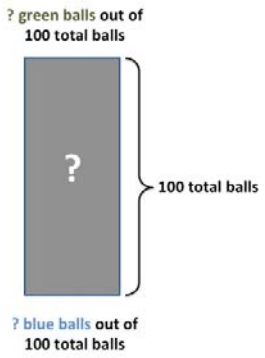
In each decision, you have to choose between two urns, graphically presented as bars. An urn always contains 100 balls of the same color (see Figure A). In the other urn there are also 100 balls, but of two different colors (see Figure B). It may happen that you cannot see how many balls of a certain color or of another color are in the urn (see Figure C).



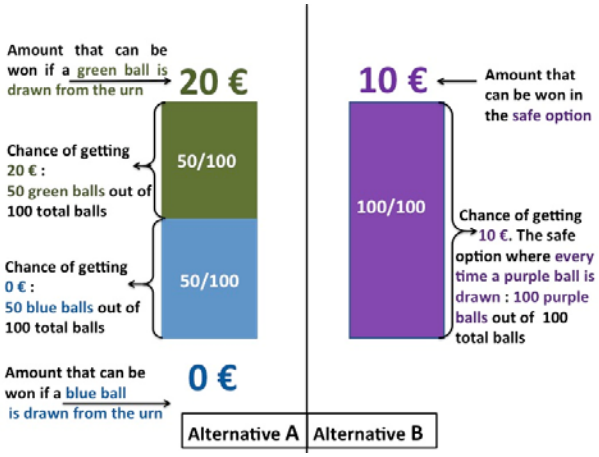
A



B



C



D

On each colored segment of the urn you can read the ratio of balls of that color. For example, the 50/100 ratio written over a green segment means that 50 of the 100 balls in the urn are green (see Figure D). Above and below the bar is written the amount you get when a ball of that color is drawn from the urn you selected (the amount is written in the same color as the ball it refers to).

The number and proportion of differently colored balls in the urn changes from choice to choice, as well as the amount you can gain if a certain colored ball is drawn. If you opt for the leftmost urn, circle the letter A under the leftmost urn. If you opt for the rightmost urn, circle the letter B under the rightmost urn. You need to decide on each page for one of the two urns.

You should decide on each page for the urn you truly prefer, as one of these choices you make will be played for real and paid to you at the end of the study. To decide which of the 33 choices will be selected for payment, you will draw yourself one of the 33 trial codes form a bag. You will then also determine the outcome of the lottery you chose in the respective trial by drawing a colored ball from the appropriate urn. We have prepared 33 different urns containing two types of colored balls in the same proportions as those presented in the 33 choices. As each choice contains two urns and at least one of the urns has 100 balls of the same color, we prepared bags with colored balls only for the urns that have two types of colored balls. So, these urns exist in reality and you will draw a ball

from one of these urns (*urns are shown to participants*). The colors of the balls have no special meaning.

If you have any questions, please raise your hand. The research assistant will come to you and answer all your questions quietly. Of course, these instructions will remain on your desk and you can re-read them anytime you want during the study.

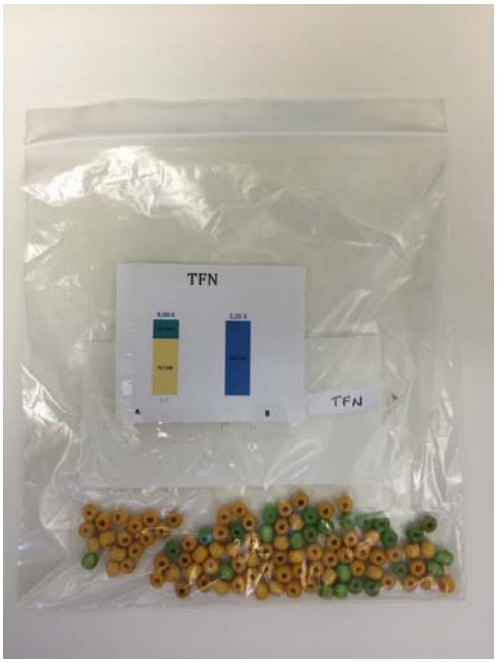
We now ask you not to talk to the other participants; if you try to communicate, we have to exclude you from the study.

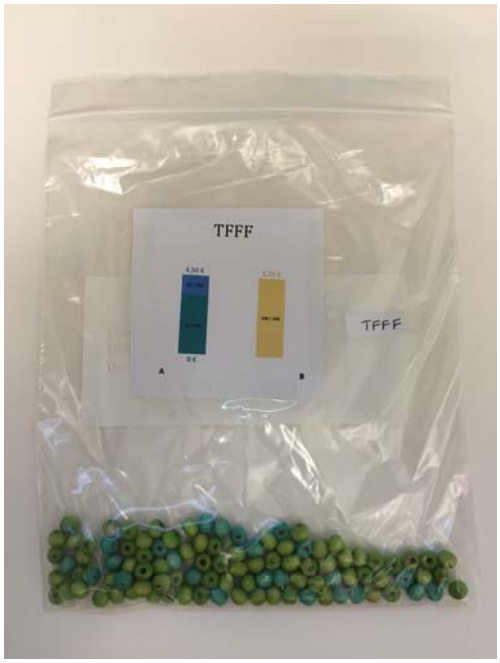
Please start by creating your personal identification code and then completing the task.

Real urns that enabled real randomness

1. 33 trial codes are put in a bag; the participant blindly draws one trial code showing what urn will be chosen further.

2. If the risky/ ambiguous urn was chosen in the respective trial, the participant blindly draws a ball from the appropriate urn and his/ her final payment is thus established.





Real and Hypothetical Social Decision-Making under Chronic Stress: Women Talk the Talk, but Don't Walk the Walk; Men Walk the Talk[30]

Abstract

Although chronic stress is a pervasive problem in contemporary societies, its effects on decision-making and cognition have not been systematically investigated. We are the first to explore the interplay between self-reported chronic stress and social preferences. We measured chronic stress with the Trier Inventory for the Assessment of Chronic Stress (TICS), a nationally validated German inventory. We measured social preferences with a dictator game decision, i.e., sharing a given amount with an anonymous counterpart. Controlling for social preferences robustness, experimenter demand effects, and the impact of method dissimilarity of economics and psychology, we implemented a 2x2x2x2 factorial design, manipulating: the framing of the decision (Give to Recipient vs. Take from Recipient), the decision maker's gender (Female vs. Male), the decision recipient's gender (Female vs. Male) and the nature of the payoff (Real € vs. Hypothetical €)[31]. We uncovered that perceived chronic stress is not related to social preferences over real payoffs for either gender, and is generally unrelated to men´s transfers. However, women's decisions over hypothetical payoffs are negatively correlated to chronic stress. This entails that perceived chronic stress does not affect social preferences as measured by real money transfers, but fosters, for women, what could be interpreted as higher self-interest, "fight-or-flight" competitive behavior, or a decrease in projected self-image positiveness.

Keywords: Chronic Stress · Social Decision-Making · Dictator Game · Framing · Hypothetical versus Real Decisions · Gender Pairing

JEL Classification: C72 · C91 · D64 · D87 · J16 · Z13

PsycINFO Classification: 2560 · 2970 · 3020 · 3040 · 3360

[30] Co-authored by Brigitte M. Kudielka and Sara E. Kettner. We would like to thank the Deutsche Forschungsgemeinschaft (DFG) under research grant number SCHW1537/1-1 for providing financial support for our research.

[31] For detailed behavioral and methodological aspects of gender pairing see Kettner and Ceccato (2014).

1 Introduction

Chronic stress is a growing concern in the modern world. Caused mainly by family or work conditions, own financial situation, or the global economy, stress affects more and more adults, their life quality, their sleeping and eating patterns, and it even translates onto the behavior of their children (APA, 2013). While some amount of stress might have motivational effects by promoting adaptation and mobilizing short-term resources necessary for survival, long-term stress, i.e., chronic stress, is known to bear only damaging effects. It gives rise to allostatic load, the ”wear-and-tear” of the body, and this often precedes chronic physiological and psychological conditions (Cacioppo, 1994; Chrousos, 2009; Juster et al., 2010; McEwen, 2004).

Despite its “pandemic” character and the fact that it alters neurological structures involved in cognition and decision-making (Gianaros et al., 2007; Lupien and Lepage, 2001; Lupien and McEwen, 1997; McEwen and Sapolsky, 1995), the direct effects of chronic stress on cognitive mechanisms and decision-making have not been consistently researched in humans. What is more, chronic stress potentially affects not only the health and solitary decisions of individuals, but might also be affecting, by eroding physical and mental health, their interpersonal relationships and the social decisions they take. However, since positive social interaction is actually a stress buffer (APA, 2015) and the vast majority of decisions are often made in social contexts (Fehr and Fischbacher, 2003), it is important to scrutinize not only disruptions over isolated cognitive processes, but also the way that stress alters well-being, relationships and interactions. We herein propose the first investigation of the effects of chronic stress on social decision-making.

We refer to chronic stress as the sum of consequences of prolonged exposure to one, single and repetitive, or multiple acute stressors. Acute stressors, in turn, are either unpredictable stimuli, or predictable stimuli, but the physiological activation they cause is uncontrollable (Koolhaas et al., 2011), i.e., one cannot simply decide to stop the specific reactions in the bodily systems. Acute stress, essentially a reaction to unpredictability or uncontrollability, is the evolution´s response which mobilizes metabolic resources to ready the body for action, i.e., to fight against danger or flight away from it. The notion is often used to denote both eustress and distress[32], because both forms of stress cause the same specific reaction in the body (Koolhaas et al., 2011)[33]. If proving

[32] The former refers to good, motivating stress, while the latter to disruptive stress, with potential negative effects.

[33] The activation of the Hypothalamic-Pituitary-Adrenal Axis (HPA), measurable through cortisol, and the activation of the Sympathetic-Adrenal-Medullary Axis (SAM), measurable through epinephrine or salivary alpha amylase (sAA) (Kirschbaum and

acute stress biologically is rather straightforward, for chronic stress there is yet no robust, directly validated measure[34] (see, for instance Cacioppo et al., 1998, McEwen, 2004; but see also Stalder and Kirschbaum, 2012). However, there exist several self-reported measures that have been successfully validated and employed in behavioral chronic stress research (for instance, Cohen et al., 1983; Fliege et al., 2005; Levenstein et al., 1993; Schulz et al., 2004). We are thus employing one of these measures, which has been nationally validated for our target population: the Trier Inventory for the Assessment of Chronic Stress, acronymed as TICS (Schulz and Schlotz, 1999; Schulz et al., 2004).

Returning to social interactions and the necessity to explore social decision-making under stress, there are two phenomena that grant the necessity for further research into the matter. First, under severe pressure or during natural disasters, both highly stressful situations, some individuals behave in manners that could be labeled as pure altruistic: they endanger themselves in order to save others or provide for others. This entails that, at least for some people, stress might be modifying social preferences or might be activating specific evolutionary care mechanisms.

The second phenomenon is less dramatic, but widely spread. Despite the predictions of the rational choice theory[35], individuals are not always only self-interested when their selfishness doesn´t bear costs, but are kind to others, to which they are not related by genes[36]. For instance, in the dictator game, money is transferred to strangers, even if the design of this task allows one to anonymously keep the entire endowment for himself/ herself without anyone ever knowing and without suffering any consequences (Camerer, 2003). Another example is blood donation, which is also anonymous to the recipient and does not involve reciprocity or mutualism, but might involve "feel-good" consequences, as this behavior is observable by others. A recent review further suggests that acute stress might be one factor triggering such acts of kindness, in immediate need situations (Buchanan and Preston, 2014). Finally, the prosociality under stress has been approached also from evolutionary psychology and biobehavioral standpoints. Taylor and colleagues (2000) speak of a "tend-and-befriend" behavior under stress, instead of the classical "fight-or-flight"

Hellhammer, 1989; Nater et al., 2006; van Stegeren et al., 2006; Whishaw and Kolb, 2005). However, this biological measure does not reliably associate with self-reported stress (see, for instance, Hjortskov et al., 2004).

[34] Hair cortisol and the cortisol awakening response (CAR) are two measures under scrutiny; for instance, the latter reliably showed that individuals exposed to bullying have lower cortisol secretion (Hansen et al., 2006; Hansen et al., 2011).

[35] This theory states that individuals behave in a selfish manner, following only to maximize their own benefit, happiness or gain. It also encompasses the idea that "more is always better", implying that in any (monetary) decision where selfishness cannot bare a cost, individuals will always take for themselves the maximum available.

[36] Gene ties motivate sharing, giving or helping, in order to promote genome survival.

response. This demeanor is theorized as being more specific to women, although the oxytocin-based mechanism that might underlie it motivates its existence in both genders (Taylor, 2006). Accounting for these phenomena and the theoretical gender-specificity of prosociality under stress, we propose to lay the foundation for researching chronic stress and social decision-making with a gender-paired task that measures social preferences in the absence of most exogenous demands and motivations: the dictator game, a widely-employed task in experimental economics.

However, there is a methodological issue that might have a major role in bridging psychological and experimental economics traditions in a reliable and externally valid experiment, when researching the impact of psychological factors in an economic task: incentives. While psychology has built immense replicable knowledge based on data stemming from self-reports and unincentivised studies, experimental economics is very strict in what concerns having a clear, monetary payment for the performance in experimental tasks. Below we give details on if and how the existence or lack of incentives can change behavior in experiments, but, for methodological soundness and disentangling motivations, we employ both procedures in two different experimental treatments: one where the sharing task in the dictator game is accomplished for real monetary payoffs, the other where the task is accomplished "as if" there were money involved, in a hypothetical fashion.

To conclude, our study is a first attempt at analyzing the effects of chronic stress on social preferences in a gender-paired design with real and hypothetical payoffs. It is important to identify eventual relations between chronic stress and social preferences because more and more individuals suffer the physiological and psychological effects of chronic stress and, under those effects, take economic decisions, interact, negotiate and share with others. In what follows we summarize the relevant literature that motivates our experimental design.

2 Literature

Research on the effects of stress on cognitive processes and decision-making has focused so far only on acute stressors. In nuce, in what regards cognitive processes under acute stress, the literature proposes that some are altered, while others are facilitated: attention narrows so that peripheral cues are ignored (Staal, 2004), reaction times decrease (Roelofs et al., 2005), feedback learning and learning from negative outcomes are reduced (Petzold et al., 2010; Preston et al.,

2007), working memory is reversibly impaired in demanding tasks (Schoofs et al., 2008), memory encoding for emotional material is disrupted, memory consolidation is generally improved (Putman et al., 2004; Smeets et al., 2008), retrieval from memory is impaired (Buchanan et al., 2006; Buchanan and Tranel, 2008; Kuhlmann et al., 2005; Smeets et al., 2008), and memory for socially relevant information as face-name association is affected in high cortisol responders (Takahashi et al., 2004).

In what concerns decision-making under acute stress, most studies explored decisions taken in uncertainty contexts, as this type of environment characterizes everyday decision-making outside the laboratory[37]. Here, the effects of acute stress are again heterogeneous, as they depend on the nature of the task (Buckert et al., 2014), but, the general conclusion so far is that the underlying decision mechanisms like dynamic strategy choice, switching from automatic to deliberative processes, feedback integration and reward and punishment sensitivity are negatively affected (Starcke and Brand, 2012). Decision-making becomes less flexible under stress (Bröder, 2000, 2003; Dougherty and Hunter, 2003; Janis et al., 1983; Janis and Mann, 1977; Keinan, 1987; Streufert and Streufert, 1981), rewards become more salient while punishments less important (Mather and Lighthall, 2012), and decisions rely heavily on intuitive, automatic processes (Evans, 2003; Reyna, 2004; Starcke and Brand, 2012). However, the way acute stress affects behavior seems to follow a time-dependent pattern. Immediately after stress exposure, decisions and behavior tend to be mostly instrumental or habitual (Schwabe et al., 2010). Later on, behavior becomes more flexible and long-term goals can be followed (Diamond et al, 2007; Williams and Gordon, 2007). This interval-dependent effect of stress raises an interesting question regarding how stress chronicity may affect decisions and behavior: does the system adapt to repeated, prolonged stressors and behavior becomes more goal-directed or is the system overridden and cannot move anymore beyond habitual reactions?

If research on the effects of acute stress on cognitive process and individual decision-making under uncertainty has laid the ground and continues to grow, two other important, related domains benefit from very limited scientific evidence. The first domain is social decision-making under acute stress, and the second concerns the effects of chronic stress on cognitive processes,

[37] We refer to uncertainty as a continuum comprising situations for which the exact final outcome is not known. They comprise both risky situations, where one knows the possible outcomes and the probabilities with which these outcomes occur, and ambiguous situations, where one knows the possible outcomes, but knows nothing about the occurrence probabilities of these outcomes. Most real-life decisions have a character of uncertainty, like those where one might be able to define the possible outcomes, but rarely compute their precise occurrence probabilities.

individual and social decision-making. The effects of chronic stress, to our knowledge, have been scrutinized only in a short-term pharmacological study that showed changes in financial risk attitudes with increased cortisol secretion (Kandasamy et al., 2013).

The initial evidence coming from the first domain we mentioned, social decision-making under acute stress, encourages the endeavor we take on in the present paper. One solid finding about the relationship between stress and social interaction is that positive social interactions before stress exposure set off increased control over stress reactivity (Christenfeld et al., 1997; Ditzen et al., 2007; Gerin et al., 1992; Heinrichs et al., 2003; Kirschbaum et al., 1995; Lepore et al., 1993; Uchino and Garvey, 1997). Also, recent evidence shows that acute stress increases prosocial[38] behavior in men (von Dawans et al., 2012) and temporarily increases altruistic punishment and decreases donations in men (Vinkers et al., 2013). Von Dawans and colleagues (2012) gave male participants in an acute stress paradigm binary choices measuring trust, trustworthiness, sharing, punishment towards an anonymous male recipient, and financial risk-taking. They then found that exposure to psychosocial stress increases non-strategic sharing[39], trust and trustworthiness, but not punishment or financial risk-taking. Vinkers and colleagues (2013) test both strategic[40] and non-strategic sharing, either immediately after or late after the induction of psychosocial stress. They find that strategic sharing is affected by acute stress only immediately after stressor onset, while non-strategic sharing is always lower under stress, independent of time. These two experiments, displaying somewhat opposing results, do have a major limitation: because the various female menstrual cycle phases and oral contraceptive consumption mediate biological stress reactivity and make control and conclusion deriving more difficult (Kirschbaum et al., 1999; Meulenberg et al., 1987), they were carried on only with male participants. However, as described in the next section, our design can and will consider both sexes, since we do not measure chronic-cortisol-mediated decisions, but self-reported chronic stress and its relation to social preferences.

A contributing review, considering also the experiments of von Dawans and colleagues (2012) and Vinkers and colleagues (2013) concludes that stress might lead to prosocial behavior, but only in specific situations (Buchanan and Preston, 2014). Based on the assessed evidence, Buchanan and Preston (2014) suggest that prosociality arises under stress only if there is saliency of

[38] We employ the term following the definition adopted by Buchanan and Preston (2014) from Eisenberg and Miller (1987): a voluntary and intentional serving of another while incurring own personal cost.
[39] The dictator game, details follow in the experimental design section.
[40] The ultimatum game, extended details are offered in the discussion section.

the recipient's need and the possibility of direct interaction between benefactor and recipient. The authors also propose two mechanisms explaining this triggered behavior. The first viable explanation is the extended activation of peculiar neural mechanisms for offspring care to strangers, i.e., taking a risky decision to help another person in need, as one would often do in order to help his/ her own children. The second mechanism is a contagion of feelings that motivates intervention, based on the mirroring of observed emotions: the benefactor intervenes or acts as a result of self-projecting in the situation. Indeed, the authors also showed experimentally on another occasion that observers of stressed participants have a proportional stress response (Buchanan et al., 2012).

Departing from the suggestions of Buchanan and Preston, we extend the realm of the investigation to social, but non-strategic situations, and to chronic, instead of acute stress. Given the extensive physiological effects of chronic stress and the strongly embedded cooperation in threating times in humans, it is also important to investigate whether chronic stress has evolved to modify social preferences *per se*, independent of direct interaction with the recipient, the salience and urgency of the recipient's need, the kinship, or the degree of danger the recipient is in. The best setting for this endeavor is a non-cooperative, socially distant context. We thus chose a double anonymous dictator game, where participants should reveal true preferences, have less reputational concerns and be subject to reduced experimenter demand effects (Hoffman et al., 1994; Koch and Normann, 2008).

Next, we preferred to implement this socially distant design with both genders, not only to get a more complete description of human behavior, but also because there is strong evidence that there might exist gender specificity: sexes' stress systems and responses differ (Kudielka and Kirschbaum, 2005; Matud, 2004), their behaviors in bargaining tasks differ (Sutter et al., 2003), their decisions in economic tasks differ (Croson and Gneezy, 2009), their behavior under acute stress varies robustly (Croson and Gneezy, 2009; Lighthall et al., 2009; Mather et al., 2009; Mather and Lighthall, 2012; Porcelli and Delgado, 2009; Preston et al., 2007) and within-gender interactive decisions are more competitive (Sutter et al., 2009).

Last but not least, following an evolutionary psychology perspective, it is also important to consider both genders, not in isolation, but in paired interaction. According to mainstream theories, interaction mechanisms appear to have evolved somewhat differential for sexes, in function of their social roles. If men, resource gatherers, might display more competitive, "fight-or-flight" responses

to stress, women, nurturers and caregivers, are more cooperative, displaying "tend-and-befriend"[41] behaviors (Taylor et al., 2000). In detail, Taylor and colleagues (2000) propose that the theoretical "fight-or-flight" response that has been used to characterize stress (Canon, 1932) is not adequate for both sexes. While physiologically the body does prepare for high energy necessities, behaviorally, females' responses appear to have developed more towards "tend-and-befriend" patterns in order to assure simultaneous self and offspring survival (Taylor et al., 2000). In later work (Taylor, 2006), Shelley Taylor proposes a model of affiliation under stress where tending and befriending behaviors are motivated by oxytocin[42], opioids and dopaminergic pathways. This affiliative behavior, while a possibility for men, who have similar neurochemical embodiment to women, is expected to appear more often in women (Taylor, 2006; Taylor et al., 2000). The reason for this is the fact that oxytocin is mediated by the nature of social contacts: if they are supportive, stress effects are attenuated, if they are hostile, stress effects may be exacerbated. And, given evolutionary social roles, the social contacts of women are often more supportive, while those of men more hostile.

Finally, in exploring the effects of perceived stress chronicity on gender-paired social decision-making, we further aim to bring together two research traditions, i.e., psychology and economics, and thus unveil reliable and externally valid behavioral patterns. We attained this experimentally by varying two factors: decisions are both incentivized and unincentivized (hypothetical)[43], and endowment ownership is varied[44]. Endowment ownership is framed as either a "Give" (from own endowment) or a "Take" (from the endowment of another participant) treatment and it was shown to potentiate opposite-sex preferences in the dictator game (Kettner and Ceccato, 2014).

The experimental variation of the reward nature (hypothetical versus real choices) helps to detect a potential hypothetical bias, i.e., when the values elicited in hypothetical choices are overestimated as compared to those in choices involving real monetary outcomes. There is sufficient evidence regarding the existence of the hypothetical bias (Camerer and Hogarth, 1999; Camerer and Loewenstein, 2004; Kang et al., 2011; Morgenstern et al., 2013), even though some authors do not find it behaviorally (Dixon et al., 2013; Kettner and Waischman, 2014; Taylor, 2013)

[41] Tending refers to self- and offspring protection, befriending to the creation of social networks that function as a stress buffer.
[42] A hormone with a stress protective role.
[43] Most research in psychology is based on self-reports and unpaid performance; a flat fee is paid for participating in the study. This implies trust in the fact that participants are able to report their thoughts, feelings and behavior in an unbiased, accurate manner. Experimental economics, on the other hand, maintains that the only way to reveal one's true preferences and behavior is through financially motivated performance.
[44] This is a robustness check and we refer to the way that the initial sum to be divided in the task is allocated; the task remains the same, it is just the framing that changes.

or at neural activation level (Gospic et al., 2013). Relevant for our design, the hypothetical bias appears to be gender specific and frame change shifts it into a "real" bias, reversing it[45] (Kang and Camerer, 2013). Some authors even report that the positive hypothetical bias[46] appears only for women (Carlsson and Martinsson, 2001; Gospic et al., 2013), while others report it only for men (Brown and Taylor, 2000). In the light of this evidence, it is important to scrutinize whether results, if gender specific, are so because of true gender differences or, if gender specificity is triggered by framing or incentive schemes, making transdisciplinary generalizations short-handed.

3 Hypotheses

In what follows we build on the literature summarized above and define three testable hypotheses to be evaluated in the results section.

Hypothesis 1 Initial findings indicate that acute stress exposure promotes prosocial economic behavior between men. Since the underlying mechanism for acute and chronic stress is identical, we expect also chronic stress to affect economic behavior in a social context.

Hypothesis 2 According to evolutionary psychology, interactions have evolved towards cooperation instead of competition, and more so for women. We thus expect that chronic stress is positively related to real money transfers, but more strongly for women than for men.

Hypothesis 3 Hypothetical decisions follow, according to the literature, the same direction as decisions with real stakes, only that the declared values are higher. If chronic stress positively affects real money transfers, we expect it to positively affect also hypothetical money transfers; further, following some authors, we expect that the hypothetical bias is stronger for women.

[45] Values elicited in real choices are higher compared to those in hypothetical choices.
[46] When the value elicited in a hypothetical decision is higher than that elicited in a decision involving real monetary outcomes.

4 Experimental Design

4.1 Procedure

We investigated the link between chronic stress and social preferences by asking participants to complete a non-strategic money sharing[47] task, i.e., a task where the sender decides over the sharing ratio of a given amount and the recipient has to accept whatever he/ she is given, as he/ she cannot change the sharing ratio or punish an unfair offer by, for instance, refusing it. This task has been widely used in experimental economics to investigate if people do share something when they have no constraints to do so and it is called the "dictator game"[48] (Forsythe et al., 1994). We implemented the task in a 2x2x2x2 design and assured it is double anonymous[49]. The four variables we manipulated in the classic dictator game are: the gender of the sender (Female or Male), the gender of the recipient (Female or Male), the frame (Give to Recipient or Take from Recipient) and the nature of the reward (Real € or Hypothetical €). Below we briefly describe the procedure, but other details can be found in Kettner and Ceccato (2014) for the gender-paired design and Kettner and Waischman (2014) for the reward nature and frame manipulation.

Upon arrival at the experimental laboratory, participants received their show-up fee in a common room. They then privately drew numbers and letters that randomly assigned decision pairing and role distribution. We used two similar experimental rooms. The participants who drew numbers pertained to the first experimental room, where the task was to decide upon transfers containing real money. Those who drew letters pertained to the second room, where their task was to decide upon hypothetical, non-monetary transfers. In the sessions where both counterparts were of the same sex, participants drew, from a common container, either a letter or a number that randomly assigned them to a designated seat in one of two experimental rooms. In the sessions where the counterparts were of opposite sex, each of the genders was directed to one of two experimental rooms and randomly drew their seat at the entrance. Both a female and a male

[47] We use "sharing" in the sense of splitting an amount of money with equal costs and benefits for giver and receiver, and not in the evolutionary psychology sense like, e.g., Trivers (1985, p.386), where sharing incurs a low cost to the giver, but a large benefit to the receiver.

[48] The name suggests the fact that the decision is non-strategic and all the decision power in this task belongs to the sender; he/ she decides how to share the proposed amount, while the receiver has no option but accepting whatever he/ she is sent (including null offers).

[49] Neither the experimenters nor the other participants could know the identity of the decision maker or link any particular decision to an identity (before, during or after the experiment).

experimenter supervised each of the two experimental rooms, since experimenter gender has the potential to bias decisions (Innocenti and Pazienza, 2008).

In the first room we elicited dictator game decisions involving real money. At the same time, in a second room, we elicited hypothetical dictator game decisions. The dictators taking hypothetical decisions were then the recipients of the transfers from dictators taking real decisions and the dictators taking real decisions were then the recipients of the transfers from the dictators taking hypothetical decisions. Importantly, none of the groups was informed about the task of their counterparts, i.e., the dictators taking real decisions found out that their receivers took hypothetical decisions and had sent them hypothetical transfers only after they took their own decision. Similarly, the dictators taking hypothetical decisions found out that their receivers took decisions involving real money and had sent them actual money only after they took their own decision.

The general procedure, in both rooms, was as follows. Once all the participants were seated, the experiment started[50]. In the private cubicle of each participant two envelopes were arranged on the table. The leftmost envelope contained the endowment: either five euros (ten fifty cent coins) and ten metal washers[51] - for the real money treatments - or a slip of paper declaring they have five hypothetical euros - for the hypothetical treatments -. In the Give (to Recipient) treatments, the leftmost envelope was labeled "Your Personal Envelope", while in the Take (from Recipient) treatments it was the rightmost envelope the one carrying this label. The rightmost envelope was the empty envelope, i.e., the one in which dictators had to put whatever they decided to be sent to the recipients in the other room. For the real money treatments dictators had to put in the envelopes precisely ten metal pieces (either fifty cent coins or metal washers), while for the hypothetical treatments dictators had to put in the envelopes a slip of paper containing their hypothetical transfer (from zero to five euros in increments of fifty cents). In the Give treatments, the rightmost envelope was labeled "Other [Female/Male] Participant's Envelope[52]", while in the Take treatments this was the leftmost envelope. That is, in the Give treatments the money obviously belonged to the sender, while in the Take treatments it belonged to the recipient.

[50] Instructions for the main treatments (Give Real, Give Hypothetical, Take Real, Take Hypothetical) are included in the Appendix.

[51] Washers were used to preserve decision anonymity, as they mimic the fifty-cent coins. If a dictator playing with real money decided to keep all the euro coins for himself/ herself, he/ she could place the metal washers in the envelope of the receiver and no one could know that inside the respective envelope coins are missing. Photos are included at the end of the Appendix.

[52] We ran the experiment in German; gender is embedded in the inflection and thus is automatically specified- on envelopes involving a male sender or recipient we used the form "Teilnehmer", which means "male participant", and on envelopes referring to a female sender or recipient we used the form "Teilnehmerin", which means "female participant".

After both types of dictators took their decisions in the two rooms, the envelopes entitled "Other [Female/Male] Participant's Envelope" were sealed by them and deposited in a common collection box. The boxes were then carried in the opposite room and envelopes were given to the recipients, who opened them and counted the contents. The hypothetical dictators received the envelopes containing the transfer of the dictators playing with real money and the dictators playing with real money received the non-monetary, declared transfers (a paper slip with hypothetically transferred amount written on it, see Appendix) of the dictators playing the hypothetical dictator game. Research assistants registered the contents of the envelopes in both rooms, privately.

Finally, participants received demographics and psychometric questionnaires, after taking their decisions, since, considering the content of the questionnaires, distributing them before the task could have primed participants or could have suggested a certain type of behavior[53].

4.2 The chronic stress measure

We measured chronic stress with the Trier Inventory for the Assessment of Chronic Stress (Schulz and Schlotz, 1999; Schulz et al., 2004), a validated German questionnaire that requires a 10-15 minutes completion time (Schwabe et al., 2008). The TICS comprises 57 items answerable on a 5-point Likert scale ("never", "infrequent", "sometimes", "frequent", "and very frequent") and reflects the participant's experiences within the last three months. It assesses chronic stress through nine subscales: "excessive workload", "excessive social demand", "pressure to be successful", "dissatisfaction at work", "mental overload at work", "lack of social recognition", "social tensions", "social isolation" and "chronic anxiety".

We ran our experiment in thirty-three sessions as close as possible after university exam periods in February, April and June 2013. We therefore counted on exam preparation and exam taking as a "natural" chronic stressor. Since this stress "treatment" is more limited in time compared to the period reflected originally in the TICS (three months), we slightly modified the questionnaire and asked participants to report frequency of specific experiences within the last month only. Reliability analysis shows that this modified version is as reliable as the original version[54]. To

[53] We are aware that it might be argued that it is equally possible that participants responded in a specific way to the questionnaires as to "justify" their behaviour in the task; we believe the double anonymous setting should have washed out this sort of effects; second, our results are specific to a certain gender and treatment, despite the random setting, which goes against the justification idea.
[54] Inter-item reliability analysis and modified TICS descriptives are included in Tables 5 and 6 in the Appendix.

determine the effect of chronic stress on social preferences while avoiding multiple testing in an already complicated study design, we followed the scoring procedure from Schwabe and colleagues (Schwabe et al., 2008): we computed a total chronic stress score by adding the 57 items and either used it as a continuous variable in correlational and regression analyses, or performed a median cut to obtain high chronic stress and low chronic stress subsamples.

4.3 Control variables

We collected additional demographic and psychometric data to control for confounds. Demographic controls covered age, economic expertise, marital status, and income. Psychometrics included factors that can interfere with chronic stress: medication for chronic conditions and contraceptives, acute stress, depression and anxiety. A Visual Analogue Scale from 0 to 100 measured perceived acute stress, and the validated German version of the HADS, the Hospital Anxiety and Depression Scale, screened for depression and anxiety (Herrmann-Lingen et al., 2011).

4.4 Participants

The experiment was conducted at the AWI Laboratory, University of Heidelberg, Germany. The initial study sample comprised 376 inexperienced participants. They were recruited from the ORSEE pool (Greiner, 2004). Our final analysis sample includes 348 of the participants. Sixteen participants were excluded because of taking prescription medication for psychiatric conditions[55], six participants for incomplete chronic stress questionnaires[56], two participants did not perform the task as instructed and five participants were of senior age. The mean age of our final sample was 22.74 years and ranged from 18 to 33 years with 50.29% women and 49.71% men. Further age means and the number of independent observations for specific reward conditions can be found in Table 1.

[55] Mainly antidepressants and sleeping pills; this might interfere with the cortisol mechanism of stress (for instance, Bhagwagar et al., 2005, Burke et al., 2005).

[56] Participant exclusion for incomplete questionnaires was performed according to the instructions delineated in the TICS manual (Schulz et al., 2004).

4.5 Statistical analysis

The data was analyzed using SPSS version 20. Tests are two-sided and the significance threshold is set at $p < .05$. Behavior was analyzed by comparing the mean amount transferred for the two independent groups (low and high stress levels) using Mann-Whitney U tests. Associations between continuous variables denoting chronic stress and transferred amounts were calculated using Spearman's rank correlations (Spearman's ρ). Finally, the robustness of the results is assessed in an OLS regression model controlling for possible confounds.

5 Results

Below, we explore the relation between chronic stress and social preferences. In (5.1.) we present mean transfers, correlations between chronic stress and transfers in the dictator game, transfer trends, and pairwise tests. We then evaluate the hypotheses defined in section (3). In (5.2.) we check the robustness of our conclusions in a regression analysis, assuring they hold independently of any potentially confounding demographic or psychological factors we measured.

5.1 Chronic stress is only related to women's hypothetical transfers

Before testing our hypotheses, we present the average transfers as percentage from the initial endowment. Subsample sizes, demographic information and transfer values are provided in Table 1, contrasting high and low stress groups. We divide the presentation into real money transfers (Real) and hypothetical money transfers (Hypothetical), as these two conditions are fundamentally different and should not be pooled. To display general trends, we first report average transfers pooled across genders ("mixed"). Gender-specific transfers in conjunction with stress levels follow. Table 2 includes Mann-Whitney U Tests comparing transfers of high stress and low stress groups for both genders and frames in the Real, Hypothetical and Real vs. Hypothetical conditions.

Table 1 shows that the hypothetical bias exists, since the transfers were significantly higher with hypothetical rewards than with real money ($p < .001$, see Table 2). On average, highly stressed participants transferred 19.88 % of the initial real endowment, and 26.36 % of the initial hypothetical endowment. This significant difference ($p = .04$) holds also for low stressed

participants: they transferred 21.49 % of the initial real endowment and 34.00 % of the initial hypothetical endowment ($p < .002$, see Table 2). However, this result was driven by females ($p < .001$, see Table 2), especially the low stressed ones ($p < .001$, see Table 2). They claimed to transfer almost double and close to "fair-share"- 43.33 % of the initial endowment - compared to what women dealing with real money actually transferred, 22.86 % of the initial endowment. Importantly, what women claimed to transfer in the hypothetical condition does not discriminate between recipient's genders: claimed transfers towards other women are, on average, the same as claimed transfers towards other men, so pairing has no effect over claims in interaction with stress. Finally, as hinted by transfer percentages in Table 1, women's behavior is significantly different from that of men (not displayed in Table 2), marginally for decisions involving actual money ($p = .09$) and highly for decisions involving pretended transfers ($p < .001$).

Table 1: Average Transfers of Highly Stressed (HS) and Low Stressed (LS) Participants in the Real and Hypothetical Conditions

	Real						Hypothetical					
	Mixed HS	Mixed LS	Female HS	Female LS	Male HS	Male LS	Mixed HS	Mixed LS	Female HS	Female LS	Male HS	Male LS
Percentage transferred	19.88 (24.17)	21.49 (21.74)	24.29 (25.90)	22.86 (21.33)	13.71 (20.30)	20.51 (22.16)	26.36 (23.45)	34.00 (26.56)	31.67 (22.63)	43.33 (25.30)	20.00 (23.09)	25.38 (25.01)
N	84	101	49	42	35	59	88	75	48	36	40	39
Age	22.66 (2.96)	22.83 (2.25)	22.58 (3.17)	22.67 (2.22)	22.77 (2.70)	22.95 (2.29)	22.68 (2.71)	22.75 (2.35)	22.46 (2.60)	23.17 (2.57)	22.95 (2.86)	22.36 (2.08)

Note: The table displays mean values (standard deviations in parentheses). The percentage transferred is calculated from the initial endowment of 5 €.

Table 2: Mann-Whitney U Tests Comparing Transfers Between Low Stress and High Stress Observations in the Real, Hypothetical and Real vs. Hypothetical Conditions

Real				Hypothetical				Real vs. Hypothetical			
R--LS-	vs.	R--HS-	p = .41	H--LS-	vs.	H--HS-	p = .08 (+)	R-----	vs.	H-----	p < .001 (***)
R-FLS-	vs.	R-FHS-	p = .88	H-FLS-	vs.	H-FHS-	p = .02 (*)	R--LS-	vs.	H--LS-	p = .002 (**)
R-MLS-	vs.	R-MHS-	p = .17	H-MLS-	vs.	H-MHS-	p = .36	R--HS-	vs.	H--HS-	p = .04 (*)
RG-LS-	vs.	RG-HS-	p = .82	HG-LS-	vs.	HG-HS-	p = .21	R-F---	vs.	H-F---	p < .001 (***)
RT-LS-	vs.	RT-HS-	p = .16	HT-LS-	vs.	HT-HS-	p = .54	R-M---	vs.	H-M---	p = .18
RGFLS-	vs.	RGFHS-	p = .24	HGFLS-	vs.	HGFHS-	p = .07 (+)	R-FLS-	vs.	H-FLS-	p < .001 (***)
RGMLS-	vs.	GMHS-	p = .33	HGMLS-	vs.	HGMHS-	p = .44	R-FHS-	vs.	H-FHS-	p = .08 (+)
RTFLS-	vs.	RTFHS-	p = .23	HTFLS-	vs.	HTFHS-	p = .72	R-MLS-	vs.	H-MLS-	p = .33
RTMLS-	vs.	RTMHS-	p = .31	HTMLS-	vs.	HTMHS-	p = .62	R-MHS-	vs.	H-MHS-	p = .23

Note: p-values are rounded to two decimals and significant results are flagged with (+) for trends where $p < .10$, with (*) for $p < .05$, with (**) for $p < .01$ and with (***) for $p < .001$. The first letter in the label of the treatment indicates the nature of the reward (R for Real or H for Hypothetical); the second letter, if existent, indicates the framing (G for Give and T for Take); the third letter, if existent, indicates the gender of the sender (F for Female and M for Male); the fourth and fifth letters constitute a syntagm and indicate the reported chronic stress level (LS for Low Stress and HS for High Stress); and the sixth letter indicates the gender of the recipient (F for Female and M for Male). A missing letter is replaced by the "-"sign and indicates that, on that particular variable, the sample has been pooled, i.e., the result is independent of the manipulation of the denoted variable.

If we look at different transfers within the same reward nature condition, we discover that it was only in the Hypothetical condition that highly stressed participants claimed to behave marginally different in the dictator game compared to low stressed participants ($p = .08$). Again, this difference in claims was strongly driven by women ($p = .02$), mainly those who faced the decision of how much to take from their counterpart in the Take framing sessions ($p = .07$). Again, women's claims did not differ between recipient genders. To summarize, we observe that real transfers did not significantly differ between participants reporting low versus high stress levels, while hypothetical transfers did; and this effect is driven by women's claims. Also, hypothetical transfers overall are significantly higher than those involving actual money.

We follow up these conclusions with the results in Table 3 in order to evaluate our hypotheses. Table 3 displays correlations between continuous chronic stress scores and dictator game transfers. As shown also by the average transfer analysis above, there was no significant

correlation between chronic stress, as measured by the continuous TICS score, and real money transfers (p = .49). With this, the data does not support Hypothesis 1 and Hypothesis 2.

Table 3: Correlations Between Chronic Stress (TICS score) and Dictator Game Transfers

Reward Nature	Sample	N	Spearman´s rho	p-value
Real	Females and Males	185	-.05	.49
	Females	91	.002	.98
	Males	94	-.13	.22
Hypothetical	Females and Males	163	-.16 (*)	.04
	Females	84	-.28 (*)	.01
	Males	79	-.13	.27

Note: (*) - correlation significant at the .05 level.

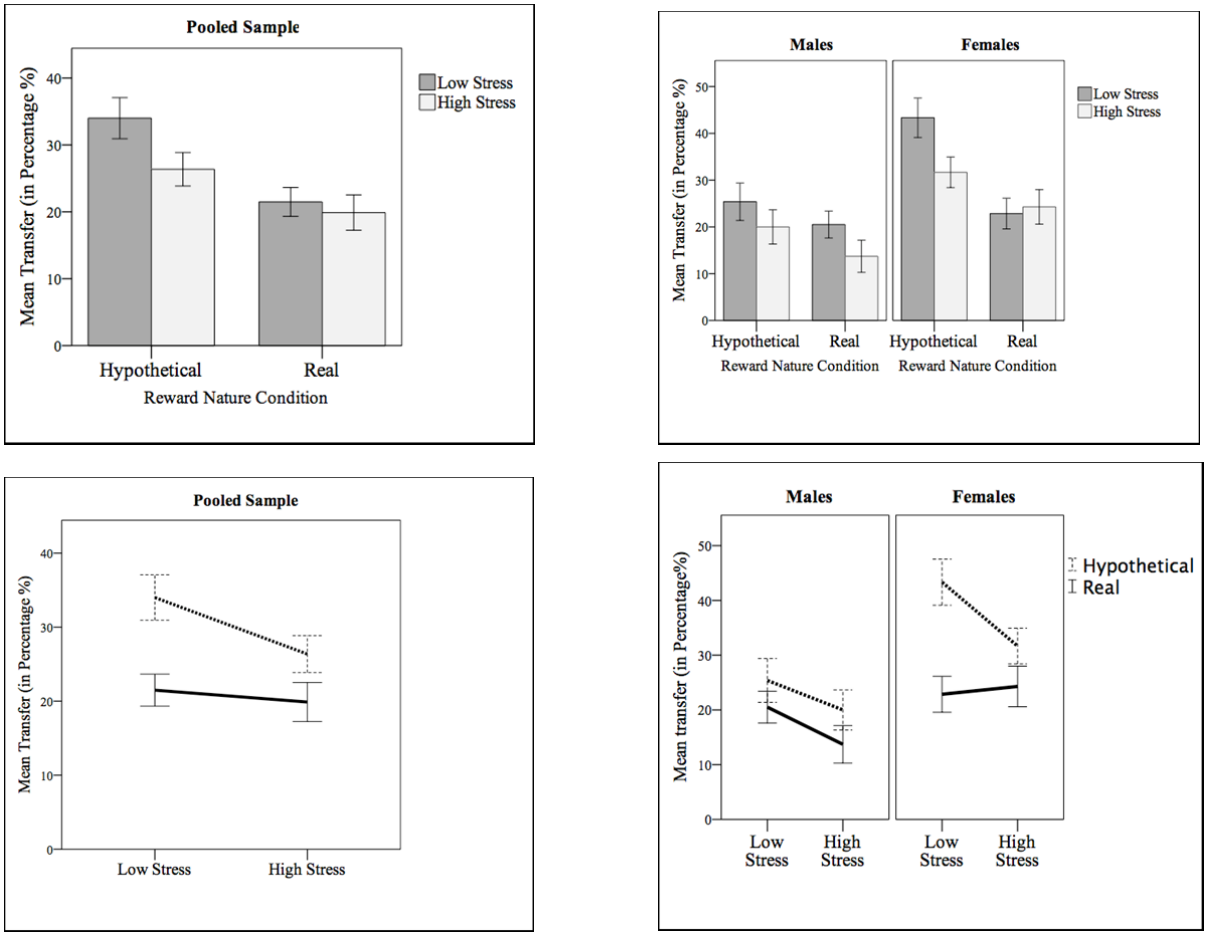
In order to evaluate Hypothesis 3 we refer to the results displayed in the lower half of Table 3. The correlation between self-reported chronic stress and declared transfers was negative and significant (p = .04), although weak (r_s = - .16). This correspondence is presented graphically in the upper left panel of Figure 1: both real and hypothetical money transfers decreased with increased chronic stress, but the decrease was significant only when decisions did not involve real money. Men have put their money where their mouth was (p = .18, see Table 2), meaning that what men in the hypothetical condition declared they would transfer is not significantly different to what men in the real condition actually transferred. Figure 1 (upper right panel) also shows that, for men, correlational trends between stress and transfers evolve in the same negative direction for both reward conditions. For women, the nature of the reward shifts the correlation signs: if in the Real condition the coefficient is null, but positive (r_s = .002, n.s.), lower transferred amounts correlate negatively with stress in the Hypothetical condition (r_s = - .28, p = .01). This is also visually displayed in Figure 1 (upper right panel). Given these, we have to reject also Hypothesis 3, as the relation between chronic stress and claimed transfers is not significant overall, but only for women. However, even if just gender specific, it is not positive as expected, but negative: the higher the perceived stress, the lower women's declared transfers.

Result 1 Chronic stress is not significantly related to real money transfers for either gender.

Result 2 Chronic stress is, generally, not positively, but negatively related to transfers in the dictator game, against the "tend-and-befriend" hypothesis.

Result 3 The negative correlation is driven by women's hypothetical decisions: that is, chronic stress is significantly related to the hypothetical decisions of women.

Figure 1: Mean Transfers (in Percentage) for Real and Hypothetical Reward Natures, Pooled Sample (left panels) and Each Gender (right panels)



Note: The first row of images displays bar charts with mean transfers in percentage for the low and high stress groups in the two different reward conditions. The first image displays mean transfers for the entire sample, whilst the second mean transfers for each gender. The second row of images displays trends for mean transfers in percentage from low to high stress groups in the two different reward conditions. The first image displays the mean transfers for the entire (pooled) sample, whilst the second image illustrates mean transfers for each gender. Error Bars represent +/- 1 standard deviation of the mean (SEM).

5.2 Women talk the talk, but don't walk the walk; men walk the talk

The pairwise comparisons and correlational analyses show clearly that chronic stress is not significantly related to real money transfers in the dictator game for either gender, but is associated with differences in hypothetical transfers between low stressed and highly stressed women. In order to put this result to further test, we ran eight regression models[57] (Table 4) where we explain transfers in percentage from the initial endowment through stress, experimental treatment conditions, and demographic and psychometric controls. Throughout these models we employ the continuous TICS score, as opposed to the median cut, in order to capture the entire variation of the data.

The first model explains pooled transfers through *chronic stress (TICS)* for both genders. The second model expands by the *reward nature* (0= Hypothetical, 1= Real) and the interaction of *reward nature x chronic stress*, while the third model adds the experimentally varied conditions: the *sender's gender (0 = Male, 1 = Female)*, the *recipient's gender (0 = Male, 1 = Female)* and the *framing (0 = Take, 1 = Give)*. Model (4) further tests Model (3) with demographic and psychometric controls: *age*, *income*, *relationship status (0= Single, 1= Relationship)*, *economics major (0= No, 1= Yes)*, *medication for chronic disease or contraceptives (0= No, 1= Yes), acute stress (VAS)*, a screening for *anxiety (HADS-A)*, and a screening for *depression (HADS-D)*. The last four models re-estimate models (3) and (4) for women (models (5) and (6)), and men (models (7) and (8)), respectively. We have chosen to retest the influence of stress on transfers, separately, for each gender, since the pairwise comparisons indicated they follow different trends: men's transfers do not differ between reward conditions and stress levels, while women's transfers are higher in the hypothetical condition and lower for the high stress group.

The regression results confirm the conclusions we drew in the previous subsection. Chronic stress explains hypothetical transfers in the dictator game, for women. The TICS score in the first model indicates the overall trend: stress has a negative effect on pooled transfers (real and hypothetical). The source of the marginal significance of this trend is revealed in the second model, where the trend is evident for hypothetical transfers, but insignificant for the real ones. If we separate the transfers by reward nature in model two, we see that the trend is highly significant and driven by the hypothetical treatment (the coefficient of the stress score is negative and significant),

[57] We ran OLS models for easiness of interpretability, but a Tobit estimation with robust standard errors (Engel, 2011), the appropriate analysis for censored data, yields the same results.

while the interaction coefficient, representing the real transfers, is positive and insignificant. Model three reconfirms the significant negative effect of stress on hypothetical transfers, but indicates a strong, positive gender effect, i.e., that females might be the ones driving the result. It also indicates that hypothetical transfers decrease with increasing stress independent of the gender of the recipient, but that transfers decrease further in the *give* framing. We discuss this extensively in Kettner and Ceccato (2014). Finally, the last model ran for both genders together shows that our result is robust to demographic and psychometric controls. The only significant coefficient of the control variables is that of the *economics major*, showing that domain-specific knowledge affects transfers negatively. This is in agreement with some existing literature, where a more rational behavior (decreased transfers) is expected for those having expertise (Marwell and Ames, 1981), but in disagreement with other results (Yezer et al., 1996).

The fifth and sixth models test whether stress has a different effect on the real and hypothetical behavior of women. Model five retests the variables manipulated in the design (*reward nature*, *framing*, and *the gender of the recipient*) and uncovers the fact that, for women, hypothetical transfers significantly decrease with increasing stress, while real transfers marginally increase with increasing stress. Model six confirms the robustness of these trends, although significance weakens. Finally, models seven and eight retest the design variables for men and, upon robustness check, show that while their transfers follow the same trends as those of women, they are not significantly explained by stress in either of the reward nature conditions. Men´s transfers are explained by the gender of the recipient and the framing (for a detailed discussion see Kettner and Ceccato, 2014).

To summarize, we find that self-reported stress as measured by the TICS robustly explains hypothetical money transfers for women in a gender-paired dictator game. It, however, does not explain transfers for men or real-money transfers for either gender. For women, decreasing stress significantly increases hypothetical transfers, but this does no longer hold when they have to share real money: women talk the talk, but don't walk the walk. Men's transfers are independent of stress and do not differ much between reward conditions: they walk the talk.

Table 4: Regression Analysis

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
Chronic Stress (TICS)	-0.0820^{+}	-0.139*	-0.137*	-0.161*	-0.174*	-0.187^{+}	-0.0987	-0.137
	(0.0425)	(0.0660)	(0.0647)	(0.0763)	(0.0819)	(0.104)	(0.107)	(0.127)
Reward Nature		-17.08*	-17.09*	-20.06**	-33.45**	-38.52***	-8.360	-10.37
(0= Hypothetical, 1=Real)		(7.331)	(7.057)	(7.401)	(10.65)	(10.86)	(10.26)	(10.78)
Reward Nature x		0.0978	0.0987	0.144^{+}	0.243^{+}	0.314*	0.0407	0.0757
Chronic Stress		(0.0845)	(0.0812)	(0.0845)	(0.126)	(0.126)	(0.120)	(0.125)
Gender Sender			10.09***	13.17***				
(0= Male, 1= Female)			(2.486)	(3.436)				
Gender Recipient			1.905	2.344	-4.206	-1.751	7.621*	6.785^{+}
(0= Male, 1= Female)			(2.513)	(2.591)	(3.583)	(3.776)	(3.462)	(3.593)
Framing			-5.447*	-5.325*	-3.493	-2.322	-7.403*	-8.290*
(0= Take, 1= Give)			(2.570)	(2.589)	(3.807)	(4.050)	(3.453)	(3.644)
Age				0.469		0.0468		1.071
				(0.519)		(0.692)		(0.732)
Income				1.314		2.250		1.653
				(2.509)		(4.008)		(3.256)
Relationship Status				-4.114		-3.812		-5.376
(0= Single,				(2.934)		(4.608)		(4.106)
1= Relationship)								
Economics Major				-6.657*		-8.252^{+}		-3.168
(0=No, 1=Yes)				(2.723)		(4.227)		(3.742)
Medication				-5.910		-5.422		-3.371
(0 = No, 1 = Yes)				(3.681)		(4.108)		(10.60)
Acute Stress (VAS)				-0.0324		-0.108		0.0749
				(0.0548)		(0.0796)		(0.0793)
Anxiety (HADS)				-0.120		-0.195		0.205
				(0.507)		(0.683)		(0.784)
Depression (HADS)				0.372		0.295		-0.128
				(0.578)		(0.948)		(0.741)
Constant	31.66***	41.17***	37.73***	30.28*	55.14***	59.30**	30.74***	7.302
	(3.710)	(5.770)	(5.728)	(14.73)	(7.070)	(20.09)	(8.940)	(20.09)
N	348	348	348	337	175	170	173	167

Note: The independent variable is the amount transferred (in percentage). Significant results are flagged with (+) for trends where $p < .10$, with (*) for $p < .05$, with (**) for $p < .01$ and with (***) for $p < .001$. Robust standard errors are reported in parenthesis.

6 Discussion

We find that self-reported chronic stress as measured by the TICS is not related to social preferences in an incentive compatible task, but is related to social preferences in a hypothetical task, especially for women. We could not confirm any of the defined hypotheses.

We first expected, following initial results from acute stress research, that chronic stress would also be connected to prosocial behavior as measured by real transfers in the dictator game. Buchanan and Preston (2014) concluded in a recent review that "stress leads to prosocial action in immediate need situations", as long as the need of the target is salient and interaction between benefactor and target took place. This conclusion is based on reviewed evidence, and explains the findings of the two existing studies on acute stress and social preferences. In an acute social stress paradigm, von Dawans and colleagues (2012) show that men are more prosocial under stress. After inducing acute social stress through socioevaluative threat (the TSST-G protocol, von Dawans et al., 2011), 34 non-economist males made binary choices. The choices measured trust, trustworthiness, sharing, and punishment towards an anonymous male recipient they might have interacted with before the task, as well as financial risk-taking. The sharing task they used is very similar to ours, i.e., the dictator game, except, being a binary choice, it only offered one of two possibilities to the decision maker: either send nothing (0 Swiss Francs) or the fair-share, i.e., half of the initial endowment. We, in contrast, measured social preferences in a somewhat more continuous manner, offering eleven sharing options, which allows for participants to express prosocial attitudes, other than sharing half of their endowment. Von Dawans and colleagues (2012) found that exposure to psychosocial stress increased sharing (higher proportion of non-zero transfers), as well as trust and trustworthiness, but did not have any effect on punishment or financial risk-taking. They motivate their findings by the theories of Taylor et al. (2000) and Taylor (2006), accounting for a "tend-and-befriend" tendency also among interacting men. In contrast to this finding, but in a different setting and dealing with another type of stress, i.e., self-reported chronic stress in our case, we find no evidence of increased prosociality with increasing stress, but the contrary. Our result is more in line with the conclusions of Vinkers and colleagues (2013).

They tested social decision-making under acute psychosocial stress with two different tasks. A sample of 80 male participants completed both a strategic sharing task (the ultimatum game) and a non-strategic sharing task (the dictator game) either immediately after stress exposure or later, 75 minutes after stress exposure. The ultimatum game is a sharing endeavor where one proposer,

exactly like in the dictator game, sends a portion of his/ her initial endowment to a receiver. However, the receiver can either accept or reject (hence called altruistic punishment[58]) the offer that he/ she was made by the proposer. If the offer is accepted, the endowment is shared as proposed. If the offer is rejected, both counterparts get nothing. Male participants in the experiment accomplished both roles in the ultimatum game: they first proposed a sharing proportion for several different endowment values and then decided on rejecting or accepting several offers from credible, but non-existent counterparts, playing the role of the receiver. After this, they played a donation dictator game, deciding how much, if anything, of 10 endowed euros to donate to Unicef. Being a dictator game, Unicef could not accept or reject the offer, and the sharing decision pertained only to the participant. The results show that the effects of acute stress on strategic sharing are time-dependent, while those on non-strategic donation are not time dependent. In detail, altruistic punishment is higher immediately following a psychosocial stressor than later, after stress exposure, since more offers are rejected in the early aftermath than in the late aftermath of stress exposure. Instead, donations in the dictator game are always reduced for stressed participants, both in the early and late aftermath of stress exposure. The authors suggest that this proves that acute psychosocial stress exposure does not modify reward sensitivity, but might decrease self-control. After the effects of stress exposure had decayed, self-control is reestablished and participants regulate and start to follow their own material interest, which overrides the necessity of punishing others[59]. Starcke et al. (2011) also find that decisions under acute stress are more self-interested in emotional moral dilemmas. The design we implemented is more similar to the one described in the second experiment (Vinkers et al., 2013) and the general trends in our results point in the same direction, towards a higher self-interest (rationality) under increased stress. Both designs presuppose no interaction with the recipient and offer a larger sharing choice set, but do not replicate increased prosociality, probably due to the lack of interaction between sender and recipient and the lack of prominence of the recipients' need. It is true that, in the case of Vinkers and colleagues acute stress, and not chronic stress is induced, and the recipient is a rather well-defined non-anonymous charity, which could exert further emotional demands. Despite that, increased stress is linked to decreased donations.

[58] Punishing what is considered to be an unfair offer received from the proposer, but at a personal cost; i.e., rejecting the offer means not only canceling the payoff of the "unfair" proposer, but also own payoff, as none of the participants receives a payoff.
[59] They start accepting less advantageous offers, as some money is always better than none.

The second hypothesis we defined follows the theory of Taylor et al. (2000) and the evidence from von Dawans et al. (2012). It advocated that, while stress should increase prosocial behaviors for both genders, this relation must be stronger for women than for men. Women are supposed to affiliate in threatening times and display a "tend-and-befriend" behavior, since they were not as independent as men in providing and surviving (Taylor et al., 2000). Instead, they acted as caregivers and child raisers, and their social context enforced them to build social support networks, i.e., collaborate with other women for creating increased security, reinforcement, and stress buffers. Men, on the other hand, as resource gatherers, while not lacking collaboration, had less of a supportive social network and were more exposed to situations specific to "fight-or flight" response, i.e., where fighting or fleeing were actual necessities. In sum, these two differential social roles and functions of sexes enabled evolution to digress between genders' behavioral stress responses, although the stress-specific physiological activation remains universal: women "tend-and-befriend", men "fight-or-flight". Shelley Taylor later defined an oxytocin-based biobehavioral model underlying affiliation under stress, proposing that the nature of social contacts mediates the effects of stress. Positive contacts diminish stress effects, negative contacts worsen them. And, given that women are theorized to beneficiate more from supportive social contacts, their stress responses should be minimized and their behavioral reactions thus more prone to collaboration. While we did find a slight but highly insignificant positive correlation between women's real money transfers and stress levels, their decisions are not relevantly different from those of men, which are negatively related to stress. Our results thus offer no posthoc support for the "tend-and-befriend" behavior of women or men under stress, but this might be motivated, beyond the lack of interaction and saliency of the recipient's need, with the type of stressor we measured[60]. As we will argue below, chronic stress, despite being based on the same underlying mechanism, might be very different from acute stress. In what concerns the interaction between benefactor and target, we purposefully tried to avoid low social distance by setting up a double anonymous context in order to investigate if chronic stress affects preferences *per se*, if it modulates the view of the social world or self-image.

Finally, we presumed that hypothetical transfers would also increase with increasing stress, and the hypothetical bias will be stronger for women. We thus incorporated a hypothetical setting, following methodological soundness, but also to discover if chronic stress, even if not powerful

[60] Taylor's theories refer rather to immediate responses to stress, i.e., acute stress. Generalizing to chronic stress might not be sufficiently motivated by the fact that the underlying biological mechanism is the same.

enough as to change social behavior, might change the way people reflect upon themselves or their relations. We indeed found that this is the case, but it is specific to women. We uncovered that under high perceived chronic stress women report themselves as displaying a "fight-or-flight" behavior, hypothetically transferring fewer resources to their counterpart. In economic terms, they think they are more rational and play closer to equilibrium. Rational theory states that individuals follow exclusively self-interest and the optimal behavior encompasses maximizing one's own payoff or utility to the point where no other higher payoff or utility can be attained. This point is defined as the equilibrium. In the dictator game we implemented, the equilibrium is situated at the point of giving nothing to the anonymous counterpart, i.e., keeping the maximum possible for the self, the entire five euro amount[61]. Importantly, participants could easily adopt this strategy, since the double-blindness of the experiment assures that there are no consequences for this, or any other behavior. In reality, despite all premises, participants "irrationally" send something to the recipient, and this is actually the case in most reported dictator games (see, for instance, Camerer, 2003).

The hypothetical behavior is expected to be an accurate description of what one would actually do in the given situation, and, thus, should mimic the trend of the behavior in the incentive compatible condition. Of course, it is reasonable to assume that, in lack of actual costs, the image that participants project through their answers might be more positive than their actual actions suggest. We should also mention an important limitation of our study: the lack of an experimental treatment where the gender of the recipient is undefined. While this would make conclusions more relevant, we still have reasons to trust our results from the current design, as we did not find anything connected to stress to be driven by gender pairing as such, but by the gender of the sender, irrespective of the recipient's gender.

Returning to the behavior of stressed women in the hypothetical condition, they seem to report a more rational behavior, proposing to transfer lower amounts than unstressed women. We link, in the context discussed above, rational behavior to the "fight-or-flight" behavioral pattern, where resources and own survival matter most. In this way, highly stressed women display more of a competitive pattern, while low stressed women, more of a tending-and-befriending pattern. However, these self-reports are rather far from the truth. When dealing with actual money and incurring costs for sharing, stressed women offer slightly higher transfers to their anonymous recipients than unstressed women, although this difference is insignificant. As such, at trend level,

[61] The equilibrium is the same for both the Give and the Take conditions, as, indifferent of whom the endowment is said to belong to, the entire decision is in the hands of the sender (dictator), while the recipient has no say over the sharing proportion.

in real behavior stress might trigger tending-and-befriending, and not fighting-or-fleeing. Interestingly, for men, although not yielding any significant difference, stress enables a decreasing trend of actual transfer that is perfectly mirrored in the hypothetical condition. Living up to the expectations of the "fight-or-flight" pattern, they declare to offer less when highly stressed, and they do offer less when highly stressed and deciding over real money.

We already mentioned that our study is a premiere in the field of chronic stress and social decision-making. As such, the only literature we can connect it to is the research on acute stress and social decision-making. Our results do not expose increased prosociality under stress and we expect that the lack of direct interaction between sender and recipient, the lack of saliency of the recipient's need (but, see Vinkers et al., 2013) and, mostly, the fact that we did not scrutinize biological acute stress, might motivate the patterns we report. Both acute and chronic stress are related to the same specific physiological activation, but they differ in exposure periods. Acute stress refers to one, momentary activation, while chronic stress entails a long-term, repeated activation. It is reasonable to expect that chronic stress, despite mediating physiological damage, might also mediate psychological habituation or adaptation to stressors and external demands. We propose, therefore, that the effects of chronic stress might have different, if not opposite results to those of acute stress, even if the bodily mechanism underlying both is the same and considerable degradation of biological systems can occur under chronic stress.

Next, another reasonable assumption is that chronic stress onset, development and perception is more strongly dependent on personal characteristics than acute stress. We did not measure, for instance, neuroticism or trait anxiety, and these kind of factors could be mediating not only stress perception, but also the way stressful experience is over- or under- reported. Finally, the existing literature on acute stress and social decision-making is based on a biological measure of stress, while we only rely on a self-report. This could further make results incomparable, as we might be measuring very different constructs. The relation between perceived and reported stress and the biological activation of the stress system is not as conveniently straightforward as one would expect: while acute stress markers do sometimes correlate with acute stress self-reports (for instance, Vinkers et al., 2013), several studies have reported opposite results (see, for instance, von Dawans et al., 2012, Hjortskov et al., 2004). In what concerns chronic stress, we are not aware of any biological measure that reliably correlates with self-reported long-term stress. However, while we do not report on biological measures on this occasion, we bring upfront the first experimental

investigation on the effects of experienced stress on economic social behavioral. In integrating our results to the field, we advance an idea for future research: not only might chronic stress be having different cognitive and behavioral effects than acute stress, but it might be that biological stress and perceived or reported stress are two different constructs, yielding different cognitive and behavioral effects.

7 Conclusion

We investigated the relation between self-reported chronic stress as measured by TICS and social preferences in a double anonymous dictator game. In order to control for experimenter demand effects, self-perception and robustness we manipulated the frame, the gender pairing and the nature of the reward. We showed that there is no significant correlation between chronic stress and social preferences dependent on real rewards for either gender. We also showed that this lack of correlation is robust to all experimental conditions and further controls. However, women's hypothetical social preferences are negatively and significantly correlated to self-reported chronic stress levels: the higher their stress, the less they declare to be willing to send to an anonymous recipient.

This strengthened rational behavior is independent of various possible controls and almost all experimental manipulations, except framing. Apparently, stressed women are even more willing to take a large proportion of the endowment when they are told the money actually belongs to the recipient then when they could make an offer from an endowment belonging to themselves. This straightforwardly goes against the hypothesized "tend-and-befriend" nature of women, but goes perfectly along with expectations of rational behavior. In terms of economic rationality[62], while men prove to be uninfluenced by perceived stress, women are less rational under low stress: they declare they would transfer a larger portion of the endowment, minimizing their gain. However, when dealing with real money, women are manly: stress has little influence on transfers and, while still sending something to their counterpart, they keep most for themselves.

[62] Having more is always better and one should maximize own payoff, irrespective of other factors.

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Appendix

Inter-item reliability analysis and descriptives of TICS scores

Table 5: Inter-item Reliability Analysis for the Original and Modified Versions of the TICS

Scale Label	Number of Items	Cronbach´s Alpha Original Version (Experience in the Last 3 Months)	Cronbach´s Alpha Modified Version (Experience in the Last Month)
ERDR	9	.90	.83
MANG	4	.84	.83
SORG	4	.88	.87
SOUE	6	.84	.85
SOZI	6	.88	.90
SOZS	6	.87	.86
SSCS	12	.91	.91
UEBE	8	.90	.92
UEFO	6	.87	.87
UNZU	8	.85	.83
Average	10	**.87**	**.87**
TICS	57	-	**.95**

Note: Cronbach´s Alpha values for the Original version are taken from the TICS manual (Schulz et al., 2004). The table rows display descriptives and analysis coefficients for the nine facets of stress comprised in nine scales (ERDR, MANG, SORG, SOUE, SOZI, SOZS, UEBE, UEFO, UNZU), a screening scale for chronic stress (SSCS), the average value of inter-item variability and the total TICS score (not existent in the original version). The nine facets of stress code the following content: pressure to be successful (ERDR), lack of social recognition (MANG), chronic anxiety (SORG), excessive social demand (SOUE), social isolation (SOZI), social tensions (SOZS), excessive workload (UEBE), mental overload at work (UEFO), and dissatisfaction at work (UNZU).

Table 6: TICS Descriptives

Sample	N	Mean	Minimum	Maximum	Median	Standard Deviation	25th Percentile	75th Percentile
Pooled	348	80.84	1	196	80.00	29.98	59.00	100.00
Females	175	83.32	1	154	85.00	28.18	65.00	101.00
Males	173	78.34	15	196	75.00	31.59	56.00	97.00
Real-Pooled	185	80.56	15	196	78.00	31.07	59.00	99.00
Hypothetical-Pooled	163	81.16	1	144	83.00	28.80	59.00	100.00
Real-Females	91	83.47	20	154	82.00	26.77	65.00	101.00
Real-Males	94	77.75	15	196	73.00	34.64	54.00	96.00
Hypothetical-Females	84	83.15	1	142	85.00	29.79	64.50	103.00
Hypothetical-Males	79	79.05	26	144	81.00	27.73	57.00	100.00

Note: The descriptives are given for the entire sample (second row), the entire sample divided by reward nature conditions (fifth and sixth row), followed by gender specific scores for each of the Real (seventh and eighth row), Hypothetical (ninth and tenth row), and Pooled Conditions (third and fourth row).

Instructions

Give Real

General Information

Dear {male} participant,

Thank you for participating in this study on decision-making. In the following you will be informed about the rules and procedures. Every {male} participant has received the same printed instructions as you did. Please take your time and read the instructions carefully.

No communication with other {male} participants

All decisions in this study are private. Please do not communicate with the other {male} participants. Otherwise, we are forced to exclude you from the experiment and you will have to forgo your payment. If you have any questions, please raise your hand. The {female/ male} experimenter will answer your question quietly.

Anonymous matching

In this study, you will be randomly matched with another {male} participant from the other room. The randomization is carried out according to the number you drew during registration at the beginning of this study. The matching will not be made public and no {male} participant can reconstruct which other {male} participant {he} is matched to.

This experiment is completely anonymous. Your identity will not be made public and you will not receive information about the identity of the other {male} participants in this room and the other {male} participants in the other room.

In order to simplify readability we forgo the gender matching. We would like to note that the use of the male (to male) form should be understood as gender-independent. For each possible gender match (female-female, male-male, female-male, male-female), instructions have been written as to clearly reflect the gender of both counterparts. As there were both a female and a male experimenter in each room, their genders are also always specified.

General information about the decision task

Both you and the matched {male} participant received 5 € for your participation at the beginning. In addition to this, you have another 5 € which is in *your personal envelope*, on the table in front of you. The other matched {male} participant has nothing (0 €).

You can now leave the amount you just received unchanged or reduce it, and increase the amount of the {male} participant you have been matched with.

How to make your decision

On the table in front of you, you see two envelopes: one is your personal envelope and the other envelope belongs to the other {male} participant. In order to distinguish between the envelopes, they are marked: your personal envelope is marked "YOUR PERSONAL ENVELOPE"; the envelope of the other {male} participant is marked "ENVELOPE OF OTHER {MALE} PARTICIPANT".

Content of the two envelopes

Your personal envelope contains a total of 20 coins, out of which ten are 50 cents coins (5 €) and ten are worthless coins (metal washers). The washers have the purpose of keeping your decision completely anonymous with respect to other persons including the {female/ male} experimenters.

The envelope of the other {male} participant is empty.

Please make sure, that your personal envelope contains ten 50 cents coins and ten worthless washers by emptying the contents onto the table in front of you.

Receipt 2: This receipt is only for accounting purposes. After you signed the receipt, we ask you to place it in the sealed collection box and continue with your decision. The sealed box is used so that the {female/ male} experimenters cannot see the name written on the receipt. All {male} participants in this room sign the second receipt. The {male} participants in the other room will not sign such a receipt.

The Decision

After you have emptied the contents of your personal envelope on the table in front of you and signed the receipt, please put exactly ten coins/washers back in your personal envelope. Similarly, put exactly ten coins/washers into the envelope of the other {male} participant. In the appendix, we present all possible decisions.

Completing the decision and sealing the envelopes

As soon as you have made your decision, put your personal envelope into your pocket (coat etc.). Please seal the envelope of the other {male} participant (i.e., use the flap-tape to seal the envelope) and place it in the box located behind you, on the floor. (*Important: Please do not hand the envelope to another person or to the {female/ male} experimenter, but place it directly in the collection box.*)

After all {male} participants in this room have made their decision, a {female/ male} experimenter will carry the box to the other room in which a second {female/ male} experimenter will take over the box and distribute the envelopes to the assigned {male} participants. Nobody in the other room is informed about your identity.

Anonymity

We have planned the experiment in a way that guarantees your anonymity at all times.

1. Your identity is never revealed to another person.
2. The {female/ male} experimenter who distributes the envelopes to the {male} participants in the other room was not present at the time you made your personal decision. He or She and the other {male} participants do not know from whom they received the envelope.
3. After the decision we will ask you to fill in an anonymous questionnaire. The questions are used for the evaluation of the study and none of your answers can be linked to your identity.

Thank you very much for your support!

Last Page of the Instructions- Give Real Treatment

You	Other {male} participant	Return to your personal envelope	Place in the envelope of other {male} participant
5 €	0 €	10 x 50 cents coins and 0 x washers	0 x 50 cents coins and 10 x washers
4.5 €	0.5 €	9 x 50 cents coins and 1 x washers	1 x 50 cents coins and 9 x washers
4 €	1 €	8 x 50 cents coins and 2 x washers	2 x 50 cents coins and 8 x washers
3.5 €	1.5 €	7 x 50 cents coins and 3 x washers	3 x 50 cents coins and 7 x washers
3 €	2 €	6 x 50 cents coins and 4 x washers	4 x 50 cents coins and 6 x washers
2.5 €	2.5 €	5 x 50 cents coins and 5 x washers	5 x 50 cents coins and 5 x washers
2 €	3 €	4 x 50 cents coins and 6 x washers	6 x 50 cents coins and 4 x washers
1.5 €	3.5 €	3 x 50 cents coins and 7 x washers	7 x 50 cents coins and 3 x washers
1 €	4 €	2 x 50 cents coins and 8 x washers	8 x 50 cents coins and 2 x washers
0.5 €	4.5 €	1 x 50 cents coins and 9 x washers	9 x 50 cents coins and 1 x washers
0 €	5 €	0 x 50 cents coins and 10 x washers	10 x 50 cents coins and 0 x washers

Take Real

General Information

Dear {male} participant,

Thank you for participating in this study on decision-making. In the following you will be informed about the rules and procedures. Every {male} participant has received the same printed instructions as you did. Please take your time and read the instructions carefully.

No communication with other {male} participants

All decisions in this study are private. Please do not communicate with the other {male} participants. Otherwise, we are forced to exclude you from the experiment and you will have to forgo your payment. If you have any questions, please raise your hand. The {female/ male} experimenter will answer your question quietly.

Anonymous matching

In this study, you will be randomly matched with another {male} participant from the other room. The randomization is carried out according to the number you drew during registration at the beginning of this study. The matching will not be made public and no {male} participant can reconstruct which other {male} participant {he} is matched to.

This experiment is completely anonymous. Your identity will not be made public and you will not receive information about the identity of the other {male} participants in this room and the other {male} participants in the other room.

In order to simplify readability we forgo the gender matching. We would like to note that the use of the male (to male) form should be understood as gender-independent. For each possible gender match (female-female, male-male, female-male, male-female), instructions have been written as to clearly reflect the gender of both counterparts. As there were both a female and a male experimenter in each room, their genders are also always specified.

General information about the decision task

Both you and the matched {male} participant received 5 € your participation at the beginning. In addition to this, the other {male} participant you are matched with has another 5 € in the envelope labeled *envelope other {male} participant*. It is found on the table in front of you. You have nothing (0 €).

You can now leave the amount he just received unchanged or reduce it, and increase your amount.

How to make your decision

On the table in front of you, you see two envelopes: one belongs to the other {male} participant and the other is your personal envelope. In order to distinguish between the envelopes, they are marked: the envelope of the other {male} participant is marked "ENVELOPE OF OTHER {MALE} PARTICIPANT"; your personal envelope is marked "YOUR PERSONAL ENVELOPE".

Content of the two envelopes

The envelope of the other {male} participant contains a total of 20 coins, out of which ten are 50 cents coins (5 €) and ten are worthless coins (metal washers). The washers have the purpose of keeping your decision completely anonymous with respect to other persons including the {female/ male} experimenters.

Your personal envelope is empty.

Please make sure, that the envelope of the other {male} participant contains ten 50 cents coins and ten worthless washers by emptying the contents onto the table in front of you.

Receipt 2: This receipt is only for accounting purposes. After you signed the receipt, we ask you to place it in the sealed collection box and continue with your decision. The sealed box is used so that the {female/ male} experimenters cannot see the name written on the receipt. All {male} participants in this room sign the second receipt. The {male} participants in the other room will not sign such a receipt.

The Decision

After you have emptied the contents of the envelope of the other {male} participant on the table in front of you and signed the receipt, please put exactly ten coins/washers back in the envelope of the other {male} participant. Similarly, put exactly ten coins/washers into your personal envelope. In the appendix, we present all possible decisions.

Completing the decision and sealing the envelopes

As soon as you have made your decision, put your personal envelope into your pocket (coat etc.). Please seal the envelope of the other {male} participant (i.e., use the flap-tape to seal the envelope) and place it in the box located behind you, on the floor. (*Important: Please do not hand the envelope to another person or to the {female/ male} experimenter, but place it directly in the collection box.*)

After all {male} participants in this room have made their decision, a {female/ male} experimenter will carry the box to the other room in which a second {female/ male} experimenter will take over the box and distribute the envelopes to the assigned {male} participants. Nobody in the other room is informed about your identity.

Anonymity

We have planned the experiment in a way that guarantees your anonymity at all times.

1. Your identity is never revealed to another person.
2. The {female/ male} experimenter who distributes the envelopes to the {male} participants in the other room was not present at the time you made your personal decision. He or She and the other {male} participants do not know from whom they received the envelope.
3. After the decision we will ask you to fill in an anonymous questionnaire. The questions are used for the evaluation of the study and none of your answers can be linked to your identity.

Thank you very much for your support!

Last Page of the Instructions- Take Real Treatment

Other {male} participant	You	Return to the envelope of the other {male} participant	Place in your personal envelope
5 €	0 €	10 x 50 cents coins and 0 x washers	0 x 50 cents coins and 10 x washers
4.5 €	0.5 €	9 x 50 cents coins and 1 x washers	1 x 50 cents coins and 9 x washers
4 €	1 €	8 x 50 cents coins and 2 x washers	2 x 50 cents coins and 8 x washers
3.5 €	1.5 €	7 x 50 cents coins and 3 x washers	3 x 50 cents coins and 7 x washers
3 €	2 €	6 x 50 cents coins and 4 x washers	4 x 50 cents coins and 6 x washers
2.5 €	2.5 €	5 x 50 cents coins and 5 x washers	5 x 50 cents coins and 5 x washers
2 €	3 €	4 x 50 cents coins and 6 x washers	6 x 50 cents coins and 4 x washers
1.5 €	3.5 €	3 x 50 cents coins and 7 x washers	7 x 50 cents coins and 3 x washers
1 €	4 €	2 x 50 cents coins and 8 x washers	8 x 50 cents coins and 2 x washers
0.5 €	4.5 €	1 x 50 cents coins and 9 x washers	9 x 50 cents coins and 1 x washers
0 €	5 €	0 x 50 cents coins and 10 x washers	10 x 50 cents coins and 0 x washers

Give Hypothetical

General Information

Dear {male} participant,

Thank you for participating in this study on decision-making. In the following you will be informed about the rules and procedures. Every {male} participant has received the same printed instructions as you did. Please take your time and read the instructions carefully.

No communication with other {male} participants

All decisions in this study are private. Please do not communicate with the other {male} participants. Otherwise, we are forced to exclude you from the experiment and you will have to forgo your payment. If you have any questions, please raise your hand. The {female/ male} experimenter will answer your question quietly.

Anonymous matching

In this study, you will be randomly matched with another {male} participant from the other room. The randomization is carried out according to the number you drew during registration at the beginning of this study. The matching will not be made public and no {male} participant can reconstruct which other {male} participant {he} is matched to.

This experiment is completely anonymous. Your identity will not be made public and you will not receive information about the identity of the other {male} participants in this room and the other {male} participants in the other room.

In order to simplify readability we forgo the gender matching. We would like to note that the use of the male (to male) form should be understood as gender-independent. For each possible gender match (female-female, male-male, female-male, male-female), instructions have been written as to clearly reflect the gender of both counterparts. As there were both a female and a male experimenter in each room, their genders are also always specified.

General information about the decision task

Both you and the matched {male} participant received 5 € for your participation at the beginning. Now imagine that in addition to this you received a second payment of 5 € and it is contained in *your personal envelope* on the table in front of you. The other matched {male} participant has nothing (0 €).

You can now leave your second, hypothetical amount of 5 € unchanged or reduce it, and increase the amount of the {male} participant you have been matched with.

How to make your decision

On the table in front of you, you see two envelopes: one is your personal envelope and the other envelope belongs to the other {male} participant. In order to distinguish between the envelopes, they are marked: your personal envelope is marked "YOUR PERSONAL ENVELOPE"; the envelope of the other {male} participant is marked "ENVELOPE OF OTHER {MALE} PARTICIPANT".

Content of the two envelopes

Your personal envelope contains a paper-slip with 5 € written on it.

The envelope of the other {male} participant contains a paper-slip with 0 € written on it.

The Decision

Now, please imagine the 5 € were real and not hypothetical.

If you wish to reduce your payment and increase the one of the other {male} participant, denote the amount (in increments of 50 cent) on the paper-slips; i.e., you denote the amount by which you wish to increase the other {male} participant's payment on the paper-slip contained in the other {male} participant's envelope. On your personal paper-slip you change the amount as well.

Example:

You wish to decrease your amount of 5 € by X € (i.e., either by 0 €, 0.50 €,... or 5 €) by which you increase the other {male} participant's amount by X € (i.e., either 0 €, 0.5 €,... or 5 €):

Then you write on the empty paper-slip contained in the other {male} participant's envelope: X € (i.e., you write either 0 €, 0.50 €, ... or 5 €).

Additionally you write on the paper-slip contained in your personal envelope: the rest that you wish to leave in your envelope (i.e., you either write 5 €, 4.50 €, ... or 0 €).

Please make sure that the amounts on both paper-slips sum up to 5 €.

Completing the decision and sealing the envelopes

As soon as you have made your decision, put your personal envelope into your pocket (coat etc.). Please seal the envelope of the other {male} participant (i.e., use the flap-tape to seal the envelope) and place it in the box located behind you, on the floor. *(Important: Please do not hand the envelope to another person or to the {female/ male} experimenter, but place it directly in the collection box.)*

After all {male} participants in this room have made their decision, an {female/ male} experimenter will carry the box to the other room in which a second {female/ male} experimenter will take over the box and distribute the envelopes to the assigned {male} participants. Nobody in the other room is informed about your identity.

Anonymity

We have planned the experiment in a way that guarantees your anonymity at all times.

1. Your identity is never revealed to another person.
2. The {female/ male} experimenter who distributes the envelopes to the {male} participants in the other room was not present at the time you made your personal decision. He or She and the other {male} participants do not know from whom they received the envelope.
3. After the decision we will ask you to fill in an anonymous questionnaire. The questions are used for the evaluation of the study and none of your answers can be linked to your identity.

Thank you very much for your support!

Paper Slips in the Two Envelopes- Give Hypothetical Treatment

Your Personal Envelope 5 € Please denote here which amount you would like to leave in this envelope: _____ (i.e., you either write 5 €, 4.50 €,... 0 €)
Other {Male} Participant's Envelope 0 € Please denote here which amount you would like to leave in this envelope: _____ (i.e., you either write 5 €, 4.50 €,... 0 €)

Take Hypothetical

General Information

Dear {male} participant,

Thank you for participating in this study on decision-making. In the following you will be informed about the rules and procedures. Every {male} participant has received the same printed instructions as you did. Please take your time and read the instructions carefully.

No communication with other {male} participants

All decisions in this study are private. Please do not communicate with the other {male} participants. Otherwise, we are forced to exclude you from the experiment and you will have to forgo your payment. If you have any questions, please raise your hand. The {female/ male} experimenter will answer your question quietly.

Anonymous matching

In this study, you will be randomly matched with another {male} participant from the other room. The randomization is carried out according to the number you drew during registration at the beginning of this study. The matching will not be made public and no {male} participant can reconstruct which other {male} participant he is matched to.

This experiment is completely anonymous. Your identity will not be made public and you will not receive information about the identity of the other {male} participants in this room and the other {male} participants in the other room.

In order to simplify readability we forgo the gender matching. We would like to note that the use of the male (to male) form should be understood as gender-independent. For each possible gender match (female-female, male-male, female-male, male-female), instructions have been written as to clearly reflect the gender of both counterparts. As there were both a female and a male experimenter in each room, their genders are also always specified.

General information about the decision task

Both you and the matched {male} participant received 5 € for your participation at the beginning. Now imagine that in addition to this the other {male} participant received a second payment of 5 € and it is contained in the *envelope other {male} participant* on the table in front of you. You have nothing (0 €).

You can now leave the hypothetical 5 € amount of the other {male} participant unchanged or reduce it, and increase your amount.

How to make your decision

On the table in front of you, you see two envelopes: one belongs to the other {male} participant and the other is your personal envelope. In order to distinguish between the envelopes, they are marked: the envelope of the other {male} participant is marked "ENVELOPE OF OTHER {MALE} PARTICIPANT"; your personal envelope is marked "YOUR PERSONAL ENVELOPE".

Content of the two envelopes

The envelope of the other {male} participant contains a paper-slip with 5 € written on it.

Your personal envelope contains a paper-slip with 0 € written on it.

The Decision

Now, please imagine the 5 € were real and not hypothetical.

If you wish to reduce the payment of the other {male} participant and increase yours, denote the amount (in increments of 50 cent) on the paper-slips; i.e., you denote the amount by which you wish to increase your payment on the paper-slip contained in your personal envelope. On the other {male} participant's paper-slip you change the amount as well.

Example:

You wish to decrease the amount of the other {male} participant of 5 € by X € (i.e., either by 0 €, 0.50 €,.. or 5 €) by which you increase your personal amount by X € (i.e., either 0 €, 0.5 €,... or 5 €):

Then you write on the empty paper-slip contained in your personal envelope: X€ (i.e., you write either 0 €, 0.50 €, ... or 5 €).

Additionally you write on the paper-slip contained in the other {male} participant's envelope: the rest that you wish to leave in the other {male} participants' envelope (i.e., you either write 5 €, 4.50 €, ... or 0 €).

Please make sure that the amounts on both paper-slips sum up to 5 €.

Completing the decision and sealing the envelopes

As soon as you have made your decision, put your personal envelope into your pocket (coat etc.). Please seal the envelope of the other {male} participant (i.e., use the flap-tape to seal the envelope) and place it in the box located behind you, on the floor. *(Important: Please do not hand the envelope to another person or to the {female/ male} experimenter, but place it directly in the collection box.)*

After all {male} participants in this room have made their decision, an {female/ male} experimenter will carry the box to the other room in which a second {female/ male} experimenter will take over the box and distribute the envelopes to the assigned {male} participants. Nobody in the other room is informed about your identity.

Anonymity

We have planned the experiment in a way that guarantees your anonymity at all times.

1. Your identity is never revealed to another person.
2. The {female/ male} experimenter who distributes the envelopes to the {male} participants in the other room was not present at the time you made your personal decision. He or She and the other {male} participants do not know from whom they received the envelope.
3. After the decision we will ask you to fill in an anonymous questionnaire. The questions are used for the evaluation of the study and none of your answers can be linked to your identity.

Thank you very much for your support!

Paper Slips in the Two Envelopes- Take Hypothetical Treatment

Other {Male} Participant's Envelope 5 € Please denote here which amount you would like to leave in this envelope: _____ (i.e., you either write 5 €, 4.50 €,... 0 €)
Your Personal Envelope 0 € Please denote here which amount you would like to leave in this envelope: _____ (i.e., you either write 5 €, 4.50 €,... 0 €)

Metal Washers Used to Preserve Anonymity

Gender-Pairing and Framing Matter in Social Decision-Making[63]

Abstract

We show that the way decision-making tasks are framed matters in a gender-paired dictator game, i.e., a money sharing task where one sender solely decides on dividing a given amount with an anonymous recipient. Our methodological experiment explores the influence of gender pairing and framing on monetary transfers in a 2x2x2 design where the sender's gender, the recipient's gender, and the frame, i.e., give from own endowment or take from the endowment of another, are varied. We are the first to combine all three variables and uncover that giving information about the gender of the recipient accommodates framing effects. If each of the three variables were to be analyzed independently, our data would confirm previous literature findings where females generally transfer more money than males to a counterpart and framing has no effect (Eckel and Grossman, 1998; Dreber et al., 2013). However, we investigate the variables in interaction and find that framing does matter when information about the recipient's gender is salient. For both genders, transfers in opposite-sex pairs are always higher than in same-sex pairs, but significantly higher in the take frame. We thus suggest that the gender composition of the sample or (beliefs about) gender pairing should be controlled for in experiments testing framing and gender differences in social interaction.

Keywords: Framing · Gender Differences · Gender Pairing · Experiment · Dictator Game · Experiment

JEL Classification: C72 · C91 · J16

PsycINFO Classification: 2970 · 3020 · 3040

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1 Introduction

Differences in decision-making between genders have been widely explored in experimental economics[64], but gender-paired interaction has been rarely considered. However, most real-life interactions do not occur with an androgynous match, because individuals have information, expectations, or, at least, beliefs about their counterpart's characteristics. It is thus conceivable that these characteristics mediate decisions. For instance, counterpart gender has been shown to mediate outcomes in strategic and non-strategic settings where the payoffs depend on the courtesy of others. In restaurants it is frequently observed that males on dates and groups of males are more generous towards waitresses than groups of females (Miller, 2000). To motivate this type of selectivity, research in evolutionary psychology argues that preferential behavior towards the opposite sex has a signaling role and can be explained by the sexual selection hypothesis (Farrelly et al., 2007). Farrelly et al. (2007) show that, in interaction, partners tend to behave more cooperatively, probably following to increase their attractiveness. This courtship behavior must have a purpose, since it is costly and non-reciprocated: it is meant to appear as being altruistically motivated and portray the person as more desirable.

Evidence also suggests that sharing is lower within same-sex pairs (Buunk and Massar, 2012). With mate competition for reproduction and survival being the norm, aggression within genders is higher (Trivers, 1972, ch. 7) and this is especially prominent for men (Buunk and Massar, 2012). However, intra-gender aggression for women also exists, probably to the same extent, but is manifested in a less overt manner: gossip, rumors and enlisting cooperation to undermine the target person (Holmström, 1992). On this line, research has shown that also women see other women as competitors when gender is salient (Buss, 1999; Campbell, 1999; Kanazawa, 2005) and they become more competitive in single-sex environments (Gneezy et al., 2003). The study by Holm (2000) similarly identifies discrimination of females in a battle of the sexes game where the better outcome is selected for oneself and the worse outcome is selected for the matched female. Lastly, Houser and Schunk (2009) show that even school-age girls are already sensitive to gender-paired interactions.

Given that gender considerations appear to be embodied in social interaction, we maintain that the gender composition of the experimental sample, gender pairing, or beliefs about it are an important factor for economic decision-making and experimental methodology. Additionally,

[64] For a summary see Croson and Gneezy (2009).

behavior in social games is often context dependent (Fehr and Schmidt, 1999) and context further interacts with gender (Croson and Gneezy, 2009), which is why the interplay of social context and gender pairing must be scrutinized.

Our study is the first to focus on the interaction of the decision maker's gender, his/ her counterpart's gender, and framing. The most promising setting for this investigation is a non-strategic, anonymous environment, as it elicits prosocial behavior in the absence of most exogenous demands. The remainder of the paper is organized as follows: in *Section 2* we summarize existing literature. *Section 3* presents the experimental design, and *Section 4* the hypotheses. The results are discussed in *Section 5* and we conclude in *Section 6*.

2 Literature

Over and over again, experiments have shown that individuals exhibit other-regarding preferences, despite rational theory predicting the contrary (Camerer, 2003). In detail, rational theory predicts that maximizing own payoff and benefit, independent of any other concerns, is the main and only motivation for humans. However, experimental work has robustly disproved this theory and has shown that other-regarding preferences, i.e., taking also into account the welfare of other people, do exist. This is observed even under conditions of experimental double-blindness (Hoffman et al., 1996), where one has nothing to gain in terms of reputation, and in contexts where reciprocity cannot be a motivational concern (Johannesson and Persson, 2000). Once established, other-regarding preferences have proven to be cross-cultural and have been motivated by constructs like inequality aversion (Fehr and Schmidt, 1999), (impure) altruism (Andreoni, 1989), Rawlsian "social welfare" preferences (Charness and Rabin, 2002), or non-monetary benefits (Aknin et al., 2013). Lastly, this less-egoistic-than-portrayed nature of humans is displayed by both genders, with some authors showing that there are gender differences *per se* in the magnitude of this behavior, while others showing that it is context that enables the gender differences.

In analyzing giving behavior in dictator games, female gender has been positively correlated with the amount transferred (Eckel and Grossman, 1998; Engel, 2011). That is, women transfer more money to their anonymous counterpart. However, the gender effect seems to be context dependent (Andreoni and Vesterlund, 2001; Bolton and Katok, 1995), since females' preferences appear to be more sensitive to social cues (Croson and Gneezy, 2009). One factor clearly

influencing social interaction is gender pairing: offers are affected by information regarding the responder gender. In an ultimatum game[65] by Solnick (2001) amounts proposed to men are larger, especially those by women. Sutter et al. (2009) expand on this finding in a power-to-take game[66], reporting that in same-sex pairs the amounts proposed are lower than those in opposite-sex pairs. Also, in a gender-paired dictator game, females transfer less to females than to males (Ben-Ner et al., 2004). However, others find that there is no effect of gender-paired transfers, i.e., women propose higher amounts regardless of the responders' gender (Eckel and Grossman, 2001). We think that these mixed results are due to different design approaches, such as the social distance between the participants and the decision elicitation method. In this paper we propose examining non-strategic gender interaction[67] in a double-anonymous setting.

Another important aspect regarding interaction is framing. Bardsley (2008) and List (2007) propose that giving in the dictator game, i.e., transferring something rather than nothing to the responder, might be just an artefact of the experimental design and dependent on the way that the decision is framed and the choice set constructed. In this matter, some authors report that framing matters in public goods and bargaining research (Andreoni, 1995; Park, 2000; Leliveld et al., 2008). However, others find no framing effects in dictator games (Dreber et al., 2013), in public goods contexts (Brandts and Schwieren, 2007), or donation games (Grossman and Eckel, 2012). Thus, the effect of framing remains unclear. But this seems to hold only until the decision maker's gender is considered and interacted with framing. A recent study by Alevy et al. (2014) demonstrates that men and women do react differently to dictator game framing when anonymity is manipulated. In contrast, Dreber et al. (2013) report that framing in interaction with gender does not matter, but that there is an overall, pure gender effect, regardless of frame, where females are more generous than males. Finally, Fujimoto and Park (2010) bring counterevidence, reporting that there are no gender differences in contributions under a positive public goods frame, but women are more generous

[65] Similar to the dictator game, but the recipient can accept or reject the sharing that the dictator (sender) proposed. If rejection occurs, both counterparts get nothing. If acceptance occurs, they get the amounts according to the sharing proposed by the sender.

[66] Similar to the ultimatum game in a take frame. Both players actually gained the amounts they hold at the beginning of the game in a real effort task. In the first stage, the decision maker (called "take authority") decides how much of the responder's money will be transferred to him in the second stage of the game. However, the responder can use his/ her own money to punish the take authority for the decision he/ she took, and the final transfer to the take authority will be based on whatever is left of the responder's endowment once punishment was deducted.

[67] Where the recipient has no role during or after the decision, and thus cannot influence the decision in any way. The sender has total freedom to express his true sharing preferences, especially under double blind anonymity (neither experimenters, nor other participants can ever know what he/ she decided).

under a negative one. We contribute to the explorations of gender-context interactions with the experiment that follows.

So far, studies only considered interactions of gender and framing where the decision's recipient was an androgynous match. Likewise, gender pairing in the dictator game has only been investigated in the give frame, i.e., where the amount to be shared is initially endowed to the sender, pointing at preferential behavior towards the opposite sex. But the question remains whether gender pairing effects are further influenced by framing, i.e., defining the endowed amount as initially belonging to the recipient. Hence, we investigate the additional influence of framing decisions on information about the recipient's gender. To our knowledge, we are the first to use the interaction of the three aspects: gender, gender pairing, and framing.

3 Experimental Design

3.1 Design

We scrutinized gender pairing and framing in a double-anonymous dictator game[68] (Hoffman et al., 1996). In a 2x2x2 between-subjects design a) the decision is framed as either give or take[69], b) the dictator gender is varied, and c) the recipient gender is varied. The basic experimental procedure, except gender pairing, is a replication of Kettner and Waichman (2014)[70].

The experiment was organized as follows: all participants were invited to the same room, signed up and received a 5 € show-up fee. They thus became aware that everybody had received the same show-up fee. Further, on this occasion they might have gotten a sense of the gender composition of the sample, but we did not rely on this, and instructions clearly delineated it later. Next, the way the experiment unfolded depended on the gender pairing of the sessions' samples. For same-sex sessions, the participants drew a number or letter indicating the room and seat to which they were randomly assigned (numbers to senders {dictators} and letters to recipients). For opposite-sex sessions, each gender was directed towards a different room and, at the entrance,

[68] Neither the experimenters nor the other participants can ever know who made what decision.
[69] Give means the amount to be shared has been defined as initially belonging to the sender; take means that the amount to be shared has been defined as initially belonging to the recipient. In both frames the sender is the only one that gets to decide how and if the amount is to be divided between himself/ herself and the recipient.
[70] Instructions are provided in the appendix.

participants drew the seat number[71]. It is possible that separating participants by gender into different rooms might create additional distance but it was the method we chose to maintain full anonymity towards experimenters and other participants.

After everyone had been assigned to a room and seated in a cubicle, the experiment began. In both rooms there were always two experimenters present - a male and a female- as experimenter gender might influence decisions (Innocenti and Pazienza, 2006). The first page of the instructions, including explanations on random matching and anonymity, was read aloud by an experimenter. The remainder was read privately by the participants. Dictators (senders) found two envelopes in their cubicles, one labeled "Your Personal Envelope" and the other labeled "Other [male/female][72] Participant's Envelope". In the give framing, 5 € (ten 0.50 € coins) together with ten metal washers were in the "Your Personal Envelope" and the "Other Participant's Envelope" was empty. In the take framing, the 5 € (ten 0.50 € coins) together with ten metal washers were in the "Other Participant's Envelope" and the "Your Personal Envelope" was empty. The metal washers ensured anonymity, as they mimic 0.50 € coins in weight, diameter, and the noise they make. After being asked to count the contents of the envelopes and check that both ten 0.50 € pieces and ten metal washers were in the correct envelope (dependent on the framing), participants made their decision. They were instructed to place ten metal pieces, either coins or washers, in the "Other Participant's Envelope" and keep the remainder for themselves. In this way, they could transfer from 0 € to 5 € in increments of 0.50 €. Neither the experimenters nor other participants could observe decisions or connect a particular identity to a decision. Once a dictator had made a decision, he/she placed the sealed envelope labeled "Other Participant's Envelope" in a collection box and filled in demographic and psychometric questionnaires. The questionnaires were matched to the decisions by means of seat numbering, i.e., each questionnaire and both envelopes a participant got were pre-labeled according to the seat number and were already laid on the table before the participants drew their seat number. After filling in the questionnaires, the participants placed them back on the table and left the room.

[71] We are aware that this might be viewed as creating additional social distance. When participants who had signed up did not arrive on time and the group was uneven in number or in terms of gender, we proceeded as follows: if the missing participant belonged to the recipient group, the participant without a partner was assigned a dictator role and his/ her decision was carried out and paired up by means of a lottery. If the missing participant belonged to the dictator group, the participant without a partner could not join the experiment.

[72] Gender is embedded in the inflection in the German language. It was therefore not required to further emphasize the recipient's gender, as one has to use the word "Teilnehmer" to define a "male participant", and the word "Teilnehmerin" to define a "female participant".

When all dictators had placed their sealed envelopes in the box, it was carried into the recipient room[73]. The experimenters in the recipient room, different from the experimenters in the sender's room and thus who were at no point present while the dictators made their decisions, randomly distributed the envelopes to the recipients. The recipients opened the envelopes and counted the contents. The experimenters in the recipient room recorded the amounts transferred by senders according to their seat number, while the recipients filled in pre-allocated demographic and psychometric questionnaires.

3.2 Implementation

The experiment took place at the AWI Lab of the University of Heidelberg in February, April, and June 2013. Data was collected in thirty-three sessions[74] with an average duration of thirty minutes. 376 participants were recruited through the ORSEE-student-pool (Greiner, 2004) after filtering for experience in similar experiments. Five participants were excluded owing to their advanced age, and other two because they had misunderstood the instructions. After exclusion, the sender sample contained a total of 195 independent observations[75]. The mean age of this sample was 22.89 and ranged from 18 to 33 years. 50.14% of the participants were women and 37.95% were majoring in economics. The metal washers' market price is between 2 and 4 cents per piece, and the majority of the participants (89.23%) attributed them a value below 50 cents with a mean of 12.01 cents (median = 4 cents). Further demographic details and the number of observations per treatment are displayed in Table 1.

[73] The ten coins/ washers that were not transferred by the dictator were placed in the personal envelope and taken home. Therefore, dictators could not reveal their decision to the experimenter by returning the metal washers.

[74] Despite the fact that we strived for a sample of 20 participants in each session, they turned out having variable number of participants because of frequent no-shows. Because of the difficulty of obtaining gender-paired samples, we preferred to collect all available observations (as long as pairing was met and conditions were always kept similar), instead of cancelling the session and having an even lengthier data collection period. Treatments were not run in any pre-determined order.

[75] A simple calculation reveals the fact that the receiver subsample is slightly smaller. Again, because of frequent no-shows, we decided to run the sessions where the number of dictators was excedentary and implement the decision as instructed, to one of the other matched receivers, by means of a lottery. Nothing changes in the experimental set up and there is no deception involved- the decision is implemented as stated in the instructions.

Table 1: Number of Independent Observations and Demographic Details per Treatment

Give Framing				
Treatment[76]	Male to Male (MM)	Male to Female (MF)	Female to male (FM)	Female to Female (FF)
Observations	N = 24	N = 23	N = 26	N = 24
Age	23.52 (24)	22.48 (22)	22.27 (22)	23.17 (23)
Individual Income (€)	678.26 (750)	691.30 (750)	601.92 (750)	650.00 (750)
Single	73.91 %	82.61 %	69.23 %	50.00 %
Household Size (N)	3.61 (3)	2.96 (3)	2.69 (2)	2.54 (2)
Game Theory	56.52 %	60.87 %	23.08 %	29.17 %
Washer Value	4.96 (2)	5.26 (2)	15.29 (5)	15.85 (2.5)
Take Framing				
Treatment	Male to Male (MM)	Male to Female (MF)	Female to male (FM)	Female to Female (FF)
Observations	N = 26	N = 25	N = 23	N = 24
Age	23.54 (22.5)	22.52 (23)	22.59 (22.5)	22.96 (22.5)
Individual Income (€)	628.85 (750)	682.00 (750)	622.73 (750)	664.58 (750)
Single	80.77 %	72.00 %	72.73 %	70.83 %
Household Size (N)	3.54 (3)	3.48 (3)	2.64 (2)	2.42 (2)
Game Theory	69.23 %	64.00 %	27.27 %	41.67 %
Washer Value	9.33 (4)	5.16 (5)	17.49 (5)	22.88 (5)

Note: The table includes mean values (where applicable, median values) and percentage frequencies.

[76] The notation used to abbreviate the eight treatments applied to the 195 observations is as follows: where relevant, framing is either G (Give) or T (Take); gender pairing is denoted with a combination of the sender's gender symbol first and the recipient's gender symbol second, i.e., M (Male) and/or F (Female) as in MM (a Male is paired with another Male).

4 Hypotheses

In the analysis that follows, we first test the robustness of the results previously reported in the literature. Namely, in (**5.1)** we check whether females generally transfer more than males and if they receive more than males. We also check whether framing does not matter. In a second step, in (**5.2**) we uncover the interaction of the three manipulated variables and test the following hypotheses:

Hypothesis 1a The Give framing does not influence the fact that females transfer more than males and females receive higher transfers than males.

Hypothesis 1ab The Take framing does not influence the fact that females transfer more than males and females receive higher transfers than males.

Hypothesis 2 Transfers in opposite-sex pairs are different from transfers in same-sex pairs; this holds independent of framing.

5 Results

5.1 Average amount transferred and frequency of non-zero transfers

The average amount transferred in the pooled decisions, i.e., in the overall sample disregarding particular treatments, is 20.92% of the initial endowment. For pairwise comparisons we use Mann-Whitney-U tests and report significance levels. Dictator gender plays a significant role in the distribution of overall transfers, while framing does not. Female dictators transfer 24.12% of the endowment, while male dictators transfer 17.76% ($p = .06$). The recipient's gender does not influence transfers significantly, as females receive 21.04% of the initial endowment and males 20.81% ($p = .65$). Finally, the framing of the decision does not play a role ($p = .68$). In the give frame 19.69% of the endowment is transferred; in the take frame 22.14% of the endowment is sent to the recipient.

For the extensive margin, we analyze the percentage of participants transferring a non-zero amount to their counterpart and compare it between genders and frames through χ^2-tests. 54.87% of

all the senders choose to transfer some money to the recipient. However, a split by dictator gender underlines the fact that females transfer more frequently than males: 61.86% of the females transfer at least 50 cents, while 54.08% do the same ($p = .05$). When we compare transfer frequencies between recipient genders and frames, no difference is found. Females receive a non-zero amount in 58.33% of the cases, while males receive a non-zero amount in 51.52% of the cases ($p = .34$). Give and take transfer frequencies are not significantly different either (55.67% versus 54.08%; $p = .82$).

In summary, looking at the pooled observations, females are more likely to transfer non-zero amounts and, on average, transfer higher amounts than males. In what concerns the recipient, males and females receive similar average amounts and do not differ at the extensive margin. Finally, average transfers and transfer frequencies do not differ between frames. In the following, we put our design to test and analyze the interaction of the three manipulated variables.

5.2 Treatment comparisons and interaction effects

Figure 1 displays the average transfers in percent for each of the eight experimental treatments. As shown on the left side (give framing), females transfer higher amounts than males to both recipient genders (on average 24.60% versus 14.47%; $p = .02$). The difference is mainly due to higher transfers to the opposite sex in the case of females and lower transfers towards the same sex in the case of males (26.54% versus 11.67%; $p = .05$). We employ "opposite sex befriending" to term this selectivity towards the opposite sex. The disparity between average transfers in the give frame, i.e., higher transfers made on average by women, disappears in the take frame (right side of Figure 1). Here, females and males transfer similar average amounts (23.62% versus 20.78%; $p = .59$). This seems to stem from a heightened opposite-sex "befriending" behavior, driven by the fact that the endowment was framed as initially belonging to the recipient: females transfer significantly more to males than to females when the endowment is defined as belonging the recipient (31.30% versus 16.25%; $p = .05$), and males transfer significantly more to females than to males when the endowment is defined as belonging to the recipient (27.60% versus 14.23%; $p = .03$). Rephrased, females take more from other females than from other males, while males take more from other males than from other females. Non-parametric tests comparing contributions between all experimental treatments are displayed in Table 2.

Figure 2 presents non-zero transfer frequencies for the eight experimental treatments. In the give frame females are on average more likely to transfer non-zero amounts (66.00% of females transfer non-zero amounts versus 44.68% of males; $p = .04$) and none of the genders discriminates one of the two recipient genders. In the take frame, a transfer frequency analysis reveals the same pattern as the analysis at the intensive margin. On average, females and males are equally likely to transfer non-zero amounts (57.45% versus 50.98%; $p = .52$). However, when we consider gender pairing, we find, again, that in opposite-sex pairs the frequency of non-zero transfers is significantly higher than in same-sex pairs. This result is robust across dictator genders and shows, again, a substantial difference in opposite-sex "befriending" behavior: females transfer non-zero amounts more frequently to males than to females (69.57% versus 45.83%; $p = .10$) and males transfer non-zero amounts more frequently to females than to males (68.00% versus 34.62%; $p = .02$).

Result 1a In the Give frame, females are generally more likely to transfer non-zero amounts and, on average, transfer higher amounts than males.

Result 1b In the Take frame, transfer frequencies and average transfers are not different between dictator genders.

Result 2 Framing matters in gender-paired decisions: opposite-sex preferences are stronger when the endowment belongs to the recipient[77]. Average transfers are higher in opposite-sex pairs, but only significantly higher in the take frame.

[77] We are claiming that the endowment belonged to the recipient, but we are aware of the fact that the dictator, having to physically manipulate the money, might have developed ownership over it.

Figure 1: Average Amount Transferred in Percent by Treatment

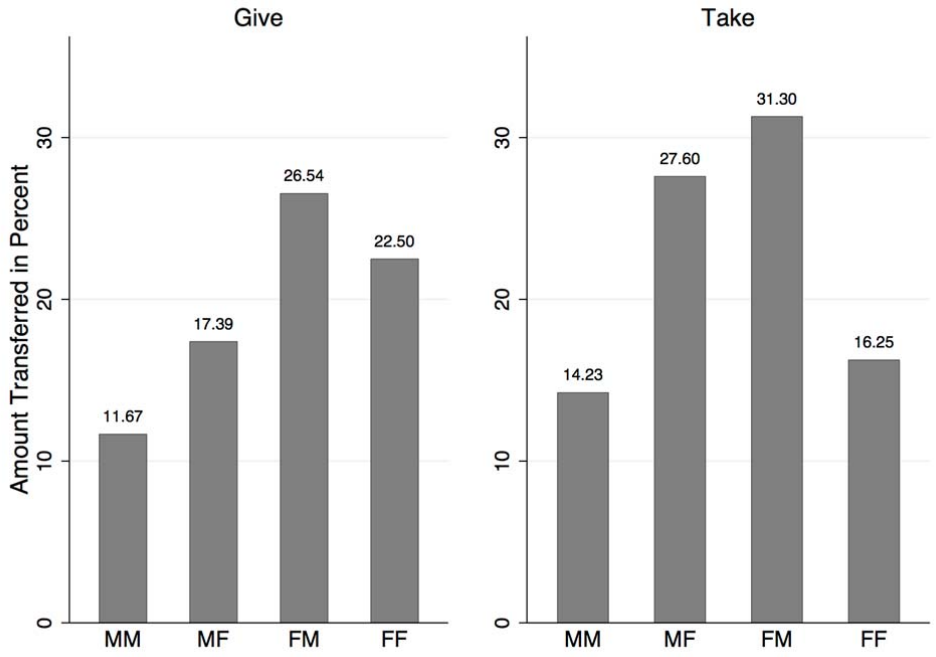

Figure 2: Non-zero Transfers: Frequencies by Treatment

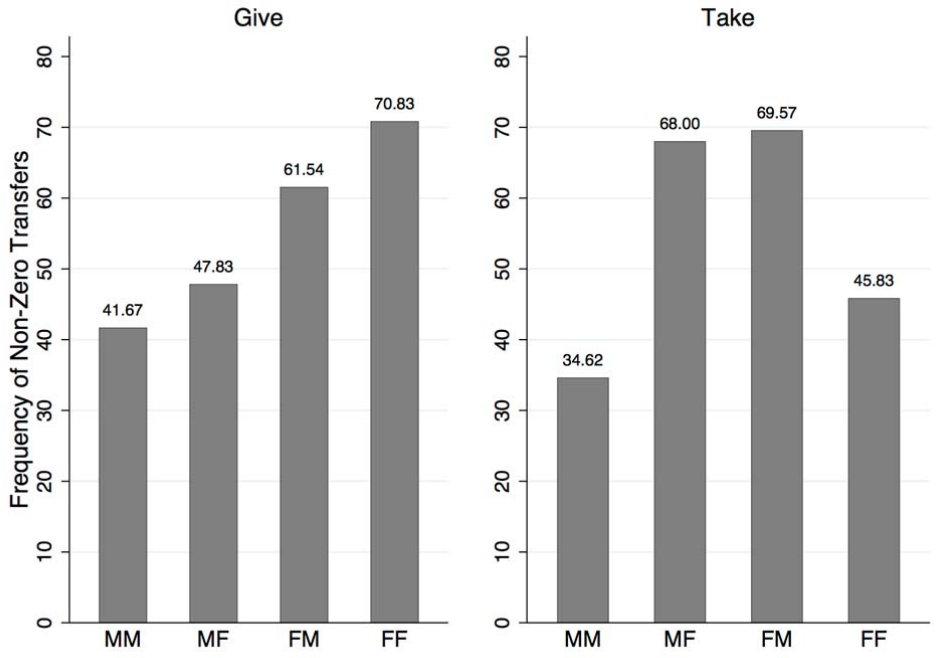

Table 2: Treatment Comparison

Gender Pairing within Give and Take Framings			
Give Framing		Take Framing	
MM vs. MF	p = .43	MM vs. MF	p = .03 (*)
MM vs. FM	p = .05 (*)	MM vs. FM	p = .02 (*)
MM vs. FF	p = .03 (*)	MM vs. FF	p = .60
MF vs. FM	p = .22	MF vs. FM	p = .66
MF vs. FF	p = .29	MF vs. FF	p = .07 (+)
FM vs. FF	p = .76	FM vs. FF	p = .05 (*)

Gender Pairing and Framing Interaction				
	TMM	TMF	TFM	TFF
GMM	p = .93	p = .02 (*)	p = .01 (**)	p = .56
GMF	p = .48	p = .12	p = .08 (+)	p = .83
GFM	p = .06 (+)	p = .76	p = .50	p = .15
GFF	p = .07 (+)	p = .50	p = .39	p = .18

Note: Results from Mann-Whitney U Tests; values rounded to the second decimal; in parentheses (+) for trends where $p < .10$, and (*) for $p < .05$ or $p = .05$. Notation of the treatments: the first letter indicates the framing (i.e., either G for Give or T for Take), the second letter indicates the gender of the dictator (i.e., either F for Female or M for Male), and the third letter shows the recipient's gender (i.e., either F for Female or M for Male).

5.3 Regression Analysis

In Table 3 we specify five regression models to explain the amounts transferred in our experiment and confirm the results of the pairwise testing. Since our data is censored, a Tobit estimation with robust standard errors is the most applicable way of testing our models (Engel, 2011)[78].

The first model solely includes the *framing* (0 = Take, 1 = Give), a dummy for the *sender's gender* (0 = Male, 1 = Female), and a dummy for the *recipient's gender* (0 = Male, 1 = Female). Model (2) expands with the interactions of the three dummies, and Model (3) adds the triple interaction. Further, to test the robustness of our results, Model (4) includes the following demographic controls: age in years, income category, relationship status (0 = Relationship, 1 = Single), and household size. Lastly, Model (5) controls for the additional effect of game theory knowledge, as we expect that trained participants will adopt a selfish behavior more often (Marwell and Ames, 1981; Frank et al., 1993).

Our results can be summarized as follows: in the limited Model (1) only the *sender's gender* reveals a positive, significant coefficient. Therefore, controlling for framing and recipient gender, we confirm the previously discussed findings where females transfer significantly more than males, independent of the experimental manipulations. In Model (2) the *sender's gender* maintains a positive, significant coefficient, while the recipient's gender coefficient also becomes positive and significant. This indicates that females receive higher transfers. *Framing*, in line with Dreber et al. (2013), does not affect transfers. However, the interaction of *sender and recipient gender* reveals a significant, negative coefficient. This shows that the recipient's gender negatively affects the positive effect of the sender's gender on the amount transferred. Plainly, the fact that females transfer generally more is reversed when the recipient is another female. This supports the results explained in the previous subsection, where in female-female pairs (and also in male-male pairs) transfers are lower than in mixed pairs. In this model, *framing* interacted with either *sender* or the *recipient's gender* does not reveal a change in the first difference. When we control for the triple interaction in Model (3), we see a weakly significant indication of how framing affects the interplay of sender and recipient genders: the second difference decreases when framing changes from Take to Give. Model (4) supports these results and further demonstrates that they are independent of age,

[78] The presented results remain valid in an OLS-model (the significance of the triple interaction effect is lower).

income, relationship status, and household size[79]. Model (5) additionally shows that holding everything else constant, education in game theory influences transfers negatively.

To parallel the extensive margin tests, we additionally apply a logistic model with robust standard errors[80]. Explanatory variables included in Models (6)-(10) are equivalent to Models (1)-(5) and results, i.e., marginal effects, are presented in Table 4. We re-confirm the previous findings: in the limited model, the *sender's gender* weakly influences transfer probabilities, revealing that females are more likely to transfer non-zero amounts than males, when not considering the experimental manipulations. This persists and is even more pronounced in the later models, where we introduce more controls. In Model (7) the coefficient of the *recipient's gender* increases, although it remains insignificant. The interaction of *sender* and *recipient gender* is negative and significant, allowing us to restate that the second difference affects the initial *sender's gender* effect. *Framing* and its interactions are insignificant and, at this point, an overall influence of framing can be rejected. Finally, the triple interaction effect in Model (8) reveals the influence of framing on the second difference of gender pairing. This should be read as follows: higher transfer frequencies exist in mixed pairs, but this effect of gender pairing is more pronounced in the take framing. Models (9) and (10) strengthen our findings, proving that the effects we claim are mediated by education, but hold independent of age, income, relationship status, and household size.

[79] We must specify that most of our participants were single and they are thus driving the results. If we re-run the models in the small subsample of individuals in a relationship, the effects we report disappear. This does not mean that there are no effects for committed individuals, but only that this subsample is too small to draw any definitive conclusions. Our data suggests that the influence of marital status should be analyzed in a larger sample.

[80] According to Hoetker (2007), the interpretation of the strength and direction of the interaction coefficients yielded in a logistic regression is, at times, counterintuitive and diverges from the straightforward interpretation in a linear, OLS model, requiring more caution. The effect of the interaction depends not only on its coefficient, but also on the individual coefficients and values of the included variables, resulting in situations where the sign of the interaction´s coefficient does not indicate the direction of the interaction´s effect, and the significance level does not necessarily reflect significant interaction effects for all observations in the sample. To overcome these potential problems, we followed the method recommended by Cornelißen & Sonderhof (2008) and ran additional analysis using the "inteff3" program for Stata, where standard errors for the marginal effects are also computed. We then uncovered that the sign of the interaction coefficients of interest hold (Gender Sender x Gender Recipient; Gender Sender x Gender Recipient x Framing), thus confirming the interpretation we propose, but the significance level of the triple interaction weakens, pointing towards trends in our results, as opposed to robust frame and gender-pairing interactions in a non-linear fashion (the analysis is attached in the Appendix).

Table 3: Tobit Regression Results

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Framing (0= Take, 1= Give)	- 3.085 (5.858)	- 11.36 (10.63)	- 0.469 (12.59)	1.311 (12.42)	- 1.906 (12.36)
Gender Sender (0= Male, 1= Female)	12.20* (5.902)	21.63* (10.58)	31.60* (12.71)	34.80** (12.60)	23.96^{+} (12.16)
Gender Recipient (0= Male, 1= Female)	2.485 (5.814)	16.96^{+} (9.864)	26.58* (11.57)	27.60* (11.58)	26.08* (11.38)
Framing x Gender Sender		12.70 (11.41)	- 7.355 (17.06)	- 10.91 (16.95)	- 8.808 (16.22)
Framing x Gender Recipient		3.662 (11.46)	- 17.05 (16.69)	- 19.23 (16.47)	- 17.83 (16.01)
Gender Sender x Gender Recipient		- 31.61** (11.47)	- 51.21** (16.73)	- 54.53** (16.76)	- 49.69** (16.08)
Framing x Gender Sender x Gender Recipient			39.66^{+} (22.94)	44.23^{+} (22.51)	41.15^{+} (21.56)
Age				0.690 (1.038)	0.872 (0.991)
Income Category				0.965 (5.511)	1.063 (5.349)
Relationship Status (0= Single, 1= Relationship)				5.011 (6.778)	5.721 (6.619)
Household Size				- 0.0946 (1.446)	- 0.470 (1.438)
Game Theory (0 = No, 1 = Yes)					- 23.35*** (5.842)
Constant	2.804 (6.340)	- 1.136 (8.550)	- 6.223 (9.671)	-27.63 (28.44)	- 14.29 (28.29)
sigma Constant	37.62*** (2.450)	36.46*** (2.399)	36.22*** (2.368)	35.76*** (2.360)	33.93*** (2.334)
N	195	195	195	193	193

Note: Significant results are flagged with (+) for trends where p < .10, with (*) for p < .05, with (**) for p < .01 and with (***) for p < .001. Robust standard errors are reported in parentheses.

Table 4: Logistic Regression Results

	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)
Framing (0= Take, 1= Give)	0.0122 (0.0723)	- 0.0785 (0.127)	0.0739 (0.144)	0.0981 (0.144)	0.0707 (0.155)
Gender Sender (0= Male, 1= Female)	0.139^{+} (0.0711)	0.199^{+} (0.119)	0.347** (0.134)	0.390** (0.134)	0.310* (0.152)
Gender Recipient (0= Male, 1= Female)	0.0690 (0.0720)	0.190 (0.117)	0.331* (0.131)	0.341* (0.133)	0.348* (0.141)
Framing x Gender Sender		0.149 (0.137)	- 0.162 (0.206)	- 0.221 (0.206)	- 0.213 (0.213)
Framing x Gender Recipient		0.0270 (0.146)	- 0.277 (0.191)	- 0.308 (0.189)	- 0.306 (0.199)
Gender Sender x Gender Recipient		- 0.272* (0.135)	- 0.519*** (0.137)	- 0.553*** (0.132)	- 0.548*** (0.142)
Framing x Gender Sender x Gender Recipient			0.447*** (0.116)	0.473*** (0.0999)	0.472*** (0.101)
Age				0.00223 (0.0138)	0.00446 (0.0141)
Income Category				- 0.00852 (0.0709)	- 0.000264 (0.0747)
Relationship Status (0= Single, 1= Relationship)				0.0862 (0.0878)	0.108 (0.0927)
Household Size				0.00223 (0.0183)	- 0.00252 (0.0175
Game Theory (0 = No, 1 = Yes)					- 0.260*** (0.0781)
N	195	195	195	193	193

Note: Significant results are flagged with (+) for trends where $p < .10$, with (*) for $p < .05$, with (**) for $p < .01$ and with (***) for $p < .001$. Robust standard errors are reported in parentheses. Additional analysis of Model (9) were ran with the inteff3 program for Stata, as suggested by Cornelißen & Sonderhof (2008) and are included in the Appendix.

6 Conclusion

We have shown that, in a non-strategic interaction, gender pairing matters and social context enables preferential money transfers towards the opposite sex. Generally, both females and males transfer more to the other gender. Yet, common favoritism is statistically significant only when the context implies that the endowment, but not the decision, belongs to the recipient. We conclude that framing matters for gender-paired dictator games.

Gender considerations are important in social interactions and social interactions are rarely context-free. Thus, the interplay between gender pairing and framing should not be ignored. If we overlook this factorial coaction, our data confirms that females generally transfer more than males and framing does not matter. But, as pointed out before, we discovered that gender-paired dictator game transfers could be context-sensitive. That is, females take significantly more from other females than from males when the money belongs to the counterpart, and give less to other females than to males when the money is theirs. In a similar fashion, males take significantly more from other males than from females when the endowment belongs to their counterpart, and give less to other males than to females when the endowment belongs to themselves.

For now, we can only speculate, but cannot disentangle the motives behind this behavior. However, we would like to point at the importance of gender pairing for social games and its interaction with framing. Additional insights into the motives behind this context-sensitive "befriending" of the opposite sex can be gained in experimental settings disentangling motivation. As an example, a setting where, in a treatment, money transfers are publicized, might reveal information about reputational concerns. Another setting, where, in a treatment, the marital status of the participants is revealed, might give information about reproduction concerns and mate competition. Finally, a setting where an experimental treatment consists of allocating endowment according to meritorious results in an effort task in both frames might shed light over these selective allocations that, in our case, are based on cash windfall.

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Appendix

Instructions

In what follows we present the translated instructions of the Give Male to Female treatment. By changing the sender or recipient gender all other give treatments were constructed. Please note that the translation highlights the gender of both sender and recipient. In German this is not required since gender is embedded in the inflection. The original German instructions, except for the gender pairing details, were first used by Kettner and Waichman (2014).

General Information

Dear (male) participant,

Thank you for participating in this study on decision-making. In the following you will be informed about the rules and procedures. Every (male) participant has received the same printed instructions as you did. Please take your time and read the instructions carefully.

No communication with other (male) participants

All decisions in this study are private. Please do not communicate with the other (male) participants. Otherwise, we are forced to exclude you from the experiment and you will have to forgo your payment. If you have any questions, please raise your hand. The (male or female) experimenter will answer your question quietly.

Anonymous matching

In this study, you will be randomly matched with another (female) participant from the other room. The randomization is carried out according to the number you drew during registration at the beginning of this study. The matching will not be made public and no (male) participant can reconstruct which other (female) participant he is matched to.

This experiment is completely anonymous. Your identity will not be made public and you will not receive information about the identity of the other (male) participants in this room and the other (female) participants in the other room.

General information about the decision task

Both you and the matched (female) participant received 5 € for your participation at the beginning. In addition to this, you have another 5 € which is in *your personal envelope*, on the table in front of you. The other matched (female) participant has nothing (0 €).

You can now leave the amount you just received unchanged or reduce it, and increase the amount of the (female) participant you have been matched with.

How to make your decision

On the table in front of you, you see two envelopes: one is your personal envelope and the other envelope belongs to the other (female) participant. In order to distinguish between the envelopes, they are marked: your personal envelope is marked "YOUR PERSONAL ENVELOPE"; the envelope of the other (female) participant is marked "ENVELOPE OF OTHER (FEMALE) PARTICIPANT".

Content of the two envelopes

Your personal envelope contains a total of 20 coins, out of which ten are 50 cents coins (5 €) and ten are worthless coins (metal washers). The washers have the purpose of keeping your decision completely anonymous with respect to other persons including the (male and female) experimenters.

The envelope of the other (female) participant is empty.

Please make sure, that your personal envelope contains ten 50 cents coins and ten worthless washers by emptying the contents onto the table in front of you.

Receipt 2: This receipt is only for accounting purposes. After you signed the receipt, we ask you to place it in the sealed collection box and continue with your decision. The sealed box is used so that the (male and female) experimenters cannot see the name written on the receipt. All (male) participants in this room sign the second receipt. The (female) participants in the other room will not sign such a receipt.

The decision

After you have emptied the contents of your personal envelope on the table in front of you and signed the receipt, please put exactly ten coins/washers back in your personal envelope. Similarly, put exactly ten coins/washers into the envelope of the other (female) participant. In the appendix, we present all possible decisions (for the appendix see last page of instructions).

Completing the decision and sealing the envelopes

As soon as you have made your decision, put your personal envelope into your pocket (coat etc.). Please seal the envelope of the other (female) participant (i.e., use the flap-tape to seal the envelope) and place it in the box located behind you, on the floor. (*Important: Please do not hand the envelope to another person or to the (male or female) experimenter, but place it directly in the collection box.*)

After all (male) participants in this room have made their decision, a (male or female) experimenter will carry the box to the other room in which a second (male or female) experimenter will take over the box and distribute the envelopes to the assigned (female) participants. Nobody in the other room is informed about your identity.

Anonymity

We have planned the experiment in a way that guarantees your anonymity at all times.

1. Your identity is never revealed to another person.
2. The (male or female) experimenter who distributes the envelopes to the (female) participants in the other room was not present at the time you made your personal decision. He or She and the other (female) participants do not know from whom they received the envelope.
3. After the decision we will ask you to fill in an anonymous questionnaire. The questions are used for the evaluation of the study and none of your answers can be linked to your identity.

Thank you very much for your support!

[*Translated Instructions of the Take Female from Female treatment. By changing the sender or recipient gender all other take treatments were constructed*.]

General Information

Dear (female) participant,

Thank you for participating in this study on decision-making. In the following you will be informed about the rules and procedures. Every (female) participant has received the same printed instructions as you did. Please take your time and read the instructions carefully.

No communication with other (female) participants

All decisions in this study are private. Please do not communicate with the other (female) participants. Otherwise, we are forced to exclude you from the experiment and you will have to forgo your payment. If you have any questions, please raise your hand. The (male or female) experimenter will answer your question quietly.

Anonymous matching

In this study, you will be randomly matched with another (female) participant from the other room. The randomization is carried out according to the number you drew during registration at the beginning of this study. The matching will not be made public and no (female) participant can reconstruct which other (female) participant she is matched to.

This experiment is completely anonymous. Your identity will not be made public and you will not receive information about the identity of the other (female) participants in this room and the other (female) participants in the other room.

General information about the decision task

Both you and the matched (female) participant received 5 € for your participation at the beginning. In addition to this, the other (female) participant you are matched with has another 5 € in the envelope labeled *envelope other (female) participant*. It is found on the table in front of you. You have nothing (0 €).

You can now leave the amount she just received unchanged or reduce it, and increase your amount.

How to make your decision

On the table in front of you, you see two envelopes: one belongs to the other (female) participant and the other is your personal envelope. In order to distinguish between the envelopes, they are marked: the envelope of the other (female) participant is marked "ENVELOPE OF OTHER (FEMALE) PARTICIPANT"; your personal envelope is marked "YOUR PERSONAL ENVELOPE".

Content of the two envelopes

The envelope the (female) participant contains a total of 20 coins, out of which ten are 50 cents coins (5 €) and ten are worthless coins (metal washers). The washers have the purpose of keeping your decision completely anonymous with respect to other persons including the (male and female) experimenters.

Your personal envelope is empty.

Please make sure, that the envelope of the other (female) participant contains ten 50 cents coins and 10 worthless washers by emptying the contents onto the table in front of you.

Receipt 2: This receipt is only for accounting purposes. After you signed the receipt, we ask you to place it in the sealed collection box and continue with your decision. The sealed box is used so that the (male and female) experimenters cannot see the name written on the receipt. All (female) participants in this room sign the second receipt. The (female) participants in the other room will not sign such a receipt.

The decision

After you have emptied the contents of the envelope of the other (female) participant on the table in front of you and signed the receipt, please put exactly ten coins/washers back in the envelope of the other (female) participant. Similarly, put exactly ten coins/washers into your personal envelope. In the appendix, we present all possible decisions (for the appendix see last page of instructions).

Completing the decision and sealing the envelopes

As soon as you have made your decision, put your personal envelope into your pocket (coat etc.). Please seal the envelope of the other (female) participant (i.e., use the flap-tape to seal the envelope) and place it in the box located behind you, on the floor. (*Important: Please do not hand the envelope to another person or to the (male or female) experimenter, but place it directly in the collection box.*)

After all (female) participants in this room have made their decision, a (male or female) experimenter will carry the box to the other room in which a second (male or female) experimenter will take over the box and distribute the envelopes to the assigned (female) participants. Nobody in the other room is informed about your identity.

Anonymity

We have planned the experiment in a way that guarantees your anonymity at all times.

1. Your identity is never revealed to another person.
2. The (male or female) experimenter who distributes the envelopes to the (female) participants in the other room was not present at the time you made your personal decision. He or She and the other (female) participants do not know from whom they received the envelope.
3. After the decision we will ask you to fill in an anonymous questionnaire. The questions are used for the evaluation of the study and none of your answers can be linked to your identity.

Thank you very much for your support!

Table A1: Last Page of the Instructions- Give Male to Female Treatment

You	Other (female) participant	Return to your personal envelope	Place in the envelope of other (female) participant
5 €	0 €	10 x 50 cents coins and 0 x washers	0 x 50 cents coins and 10 x washers
4.5 €	0.5 €	9 x 50 cents coins and 1 x washers	1 x 50 cents coins and 9 x washers
4 €	1 €	8 x 50 cents coins and 2 x washers	2 x 50 cents coins and 8 x washers
3.5 €	1.5 €	7 x 50 cents coins and 3 x washers	3 x 50 cents coins and 7 x washers
3 €	2 €	6 x 50 cents coins and 4 x washers	4 x 50 cents coins and 6 x washers
2.5 €	2.5 €	5 x 50 cents coins and 5 x washers	5 x 50 cents coins and 5 x washers
2 €	3 €	4 x 50 cents coins and 6 x washers	6 x 50 cents coins and 4 x washers
1.5 €	3.5 €	3 x 50 cents coins and 7 x washers	7 x 50 cents coins and 3 x washers
1 €	4 €	2 x 50 cents coins and 8 x washers	8 x 50 cents coins and 2 x washers
0.5 €	4.5 €	1 x 50 cents coins and 9 x washers	9 x 50 cents coins and 1 x washers
0 €	5 €	0 x 50 cents coins and 10 x washers	10 x 50 cents coins and 0 x washers

Table A2: Last Page of the Instructions- Take Female from Female Treatment

Other (female) participant	You	Return to the envelope of the other (female) participant	Place in your personal envelope
5 €	0 €	10 x 50 cents coins and 0 x washers	0 x 50 cents coins and 10 x washers
4.5 €	0.5 €	9 x 50 cents coins and 1 x washers	1 x 50 cents coins and 9 x washers
4 €	1 €	8 x 50 cents coins and 2 x washers	2 x 50 cents coins and 8 x washers
3.5 €	1.5 €	7 x 50 cents coins and 3 x washers	3 x 50 cents coins and 7 x washers
3 €	2 €	6 x 50 cents coins and 4 x washers	4 x 50 cents coins and 6 x washers
2.5 €	2.5 €	5 x 50 cents coins and 5 x washers	5 x 50 cents coins and 5 x washers
2 €	3 €	4 x 50 cents coins and 6 x washers	6 x 50 cents coins and 4 x washers
1.5 €	3.5 €	3 x 50 cents coins and 7 x washers	7 x 50 cents coins and 3 x washers
1 €	4 €	2 x 50 cents coins and 8 x washers	8 x 50 cents coins and 2 x washers
0.5 €	4.5 €	1 x 50 cents coins and 9 x washers	9 x 50 cents coins and 1 x washers
0 €	5 €	0 x 50 cents coins and 10 x washers	10 x 50 cents coins and 0 x washers

Table 5: Probit Regression Results

	Model (9b)	Marginal Effects inteff3 at means	Marginal Effects inteff3 average ME
Framing (0= Take, 1= Give)	0.246 (0.366)	0.010 (0.073)	0.011 (0.069)
Gender Sender (0= Male, 1= Female)	1.030** (0.387)	0.159* (0.074)	0.151* (0.070)
Gender Recipient (0= Male, 1= Female)	0.892* (0.368)	0.059 (0.074)	0.065 (0.069)
Framing x Gender Sender	-0.552 (0.528)	0.132 (0.144)	0.135 (0.137)
Framing x Gender Recipient	-0.789 (0.523)	0.042 (0.146)	0.036 (0.137)
Gender Sender x Gender Recipient	-1.601** (0.535)	-0.274+ (0.143)	-0.272* (0.138)
Framing x Gender Sender x Gender Recipient	1.803* (0.747)	0.682* (0.276)	0.678 (1.539)
Age	0.005 (0.035)		
Income Category	-0.025 (0.177)		
Relationship Status (0= Single, 1= Relationship)	0.218 (0.215)		
Household Size	0.004 (0.044)		
Constant	-0.667 (0.957)		
N	195		

Note: Significant results are flagged with (+) for trends where $p < .10$, with (*) for $p < .05$, with (**) for $p < .01$ and with (***) for $p < .001$. Robust standard errors are reported in parentheses. The first column reports the coefficients for the additional analysis of Model (9) ran with the inteff3 program for Stata, as suggested by Cornelißen & Sonderhof (2008). The second column includes the marginal effect at means; while the third column provides average marginal effects for individuals.

Concluding Remarks

This dissertation followed to inaugurate experimental research on economic decision-making under chronic stress. Contributing also to the investigation of reliable biological measures for chronic stress and to methodological developments regarding gender-paired sharing, two externally valid, relevant types of decisions have been considered: decisions under uncertainty, mainly risk-taking, and decisions in social contexts, embedded in social preferences.

The first study investigated if findings from acute stress research on decision-making under risk extended also to chronic stress and chronic cortisol exposure. Namely, the fact that acute stress affects risk-taking was extended and tested into an experiment measuring risk-taking through several parameters, as well as ambiguity-taking in connection to perceived chronic stress as reflected in the Trier Inventory for the Assessment of Chronic Stress, and chronic cortisol exposure assessed in human hair. Further, two important findings in the literature could be retested: the gender differences in self-reported stress measures and the gender differences in risk attitudes. The results unveiled a significant, positive correlation between chronic stress and factual risk-taking for both genders, correlation that was robust to multiple demographic and psychometric controls. However, this association was stronger for women than for men. Moreover, the gender differences maintained, in the direction predicted by the literature, in risk-taking, independent of stress, and, at trend level, in self-reported stress and risk-taking measures. In what regards cortisol exposure assessed in hair samples, there was no relation between it and risk-taking, or between it and self-reported chronic stress. Interestingly and worth more detailed investigations, long-term averaged cortisol was associated, at trend level, with men's gambling of owned money.

In the second study, for reasons detailed below and in the discussion section of the research mentioned above, only self-reported chronic stress assessed by the Trier Inventory for the Assessment of Chronic Stress was used as a chronic stress proxy. In a basic attempt to analyze the effects of chronic stress on social preferences *per se*, social decision-making was elicited in a gender-paired, double-anonymous dictator game with real and hypothetical payoffs. Initial evidence from a singular experiment on dictator game giving among males and acute stress advanced the idea

that stress increases prosociality. Departing from this, the second study presented in this thesis checked experimentally if this conclusion would arise also in relation to chronic stress, and in various gender-paired conditions, beyond male-only interactions. Also, the reported higher cooperation specific to women was tested, along with the effect that incentives, in interaction with stress, might have on behavior. No significant correlation between chronic stress and social preferences dependent on incentivized behavior was found for either gender, independent of controls. However, the way that decisions are motivated matters, since women's hypothetical social preferences were negatively and significantly correlated to self-reported chronic stress levels: the higher their perceived stress, the lower their willingness to share with an anonymous recipient.

Finally, the third study supplied valuable methodological insights that are not only relevant for experimental economics, but also for experiments conducted in psychology and social psychology and, especially, in stress research. Because of marked differences in the hormonal make-up of men and women[81], men-only samples have long been preferred in stress research. However, when aiming to control for gender differences, and, most important, when targeting to unravel the effects of stress in social contexts or social interactions, both genders have to be included and the pairing of genders further supplies information about specific patterns. While women have been included in multiple studies on stress, and hormonal interferences have been controlled for with variables like the menstrual cycle phase and oral contraceptive treatment, gender-pairing in social decision contexts under stress has not been investigated so far. The third study showed, in a purely methodological construction and independent of stress measures, that gender-pairing matters, especially in interaction with framing, i.e., the way that the decision was defined. Namely, both women and men prefer the opposite sex when it comes to money sharing, but this is statistically significant only when the amount to be shared is defined as belonging to the recipient in the first place. Thus, genders adapt their behavior in function of the gender of their counterpart, but also in relation to how decisions are delineated.

The results and their possible underlying motivations are discussed in detail for both studies focusing on chronic stress and economic decision-making in their respective sections. In what follows, the overarching aspects worth noting for future research are outlined. Thereupon, possible future contributions are suggested, in order to advance stable and reliable methods in stress and decision-making research, as well as to produce further replicable knowledge and new insights: a

[81] These specific hormones further interact with stress hormones.

detailed investigation of what enables gender differences in self-reported stress; an account of interindividual variability in stress reactivity, sensitivity, and awareness; an ecological assessments for the measurement of perceived stress; an evaluation of personal characteristics as mediators of stress reactivity and perception; and, finally, the employment of real-world compatible motivations in laboratory tasks.

The first aspect worth mentioning is that perceived chronic stress is significantly related to economic decision-making. With a notable gender emphasis on women´s behavior, chronic stress positively relates to risk-taking in the gain domain and negatively relates to hypothetical money transfers in the dictator game. However, this relation is correlational and does not allow for causal inferences. In what concerns the gender difference, it might be generated by multiple motives, but two plausible causes are the increased stress sensitivity of women, and the increased proneness to report more symptoms, again, of women. When employing self-reported measures it is important to discover if there is a gender specific tendency to purely accuse more symptoms, since this grants false comparisons between genders. If, however, the over-reporting is heterogeneous *per se,* having elemental causes like higher self- and bodily-awareness, greater sensitivity, or frequent self-assessment, research could initiate treating genders as separate, particular cases, where the perceived impact of various conditions and states should be differentially evaluated. This is a first important avenue of research that could have immediate, valuable consequence on methodology and research practices, while motivating some of the reported gender differences in the literature.

The second relevant aspect is the measurement of chronic stress. The concept of "chronic stress" was clearly equated to perceived stress exposure throughout this thesis, but a supplementary, biological measure exists and initial expectations were that it would reflect similar, correlated levels to the self-reported assessments. As shown in the first study in two different samples, the Trier Inventory for the Assessment of Chronic Stress (TICS) or the Perceived Stress Scale (PSS) and chronic cortisol exposure seem to diverge, possibly reflecting different aspects of prolonged stress exposure. This points somewhat back to the idea itemized before, of heterogeneity in sensitivity or awareness to stress, as some individuals might be highly reactive to stressors but less aware, while others might have low reactivity but higher awareness, and these differences complicate straightforward, correlational analyses between cortisol reactivity, perceived distress and behavior. Also, the gap could pertain to the populations targeted in the experiments, as their stress levels might be insufficient to elicit a marked cortisol response. Nonetheless, some smaller effect size of a

positive association is reasonable to be expected even in this case. Finally, the measures themselves might be partisan to retrospective bias, for the self-reports, and to procedural inadvertences, for the hair cortisol. While the literature offers the alternative of the cortisol awakening response (CAR) for the biological facet of prolonged stress, self-reports could be replaced in a second future research avenue: using daily assessments over a longer period to obtain an averaged measure of perceived stress. While this might still be subject to heterogeneity in self-reporting and stress reactivity, which should be anyway controlled for in any future study, it could provide a more accurate evaluation of the experienced stress. Furthermore, besides controlling for the heterogeneity in stress reactivity and stress perception, mediated or not by gender, there is a constellation of factors that should also be accounted for, since they could enrich the models derived in stress research on economic and non-economic decision-making: personal characteristics as neuroticism and trait anxiety could further mediate stress reactivity and stress perception.

Lastly, the discussion has to encompass the idea of how elicited behavior is motivated. It was clearly shown in the second study that behavior differs between real and hypothetical payments and that stress is related only to hypothetical decisions, with incentives washing out any association between stress and money transfers. While the hypothetical decisions do indicate the same direction and could therefore serve as initial evidence, incentivized behaviors manage to exclude alternative motivations like, to name a few, reputational concerns, the wish to impress, over-represented positive self-image, or responding to believed experimenter demand. To strengthen the matter, the first study has shown that behavior in an incentive-compatible task relates strongly and significantly to actual behavior where one´s previously owned money is at risk. It must be that, given these observations, incentivized experiments offer better predictions concerning behavior outside the laboratory for demeanor that is ultimately financially motivated, while unincentivised experiments better predict decisions and behavior that cannot be financially motivated. This should be carefully noted for future experimental work on economic decision-making and stress, versus non-economic decision-making and stress.