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ABSTRACT

Prenatal exposure to hormones, and to sex hormones in particular, exerts organizational effects on the brain and these have observable behavioral correlates in adult life. There are reasons to expect that social behaviors—which are fundamental for the evolutionary success of humans—might be related to biological factors such as prenatal sex hormone exposure. Nevertheless, the existing literature is inconclusive as to whether and how prenatal exposure to testosterone and estrogen, proxied by the second-to-fourth digit ratio (2D:4D), may predict non-selfish behavior. Here, we investigate this question using economic experiments with real monetary stakes and analyzing five different dimensions of social behavior in a comparatively large sample of Caucasian participants (n=560). For both males and females, our results show no robust association between right- or left-hand 2D:4D and generosity, bargaining, or trust-related behaviors. Since 2D:4D is thought to be a marker for status, we set-up and test the hypothesis that 2D:4D explains prosocial behavior only for people with low subjective wellbeing who are in need for status. Using two different measures of subjective wellbeing, we find considerable support for our hypothesis, especially among males. These results contribute to the debate regarding the context-dependent interpretation of the effect of prenatal hormone exposure on behavior by suggesting that important moderating factors may explain the differing results in the literature. In particular, we uncover the importance of accounting for the subjective nature of need for status, which has been largely overlooked in previous work.

INTRODUCTION

Human social behavior captivates researchers from many different disciplines, both in the natural and the social sciences (Axelrod and Hamilton, 1981; Fehr and Fischbacher, 2003; Nowak, 2006). One of the key features of human social architecture is that institutions are often built upon the sporadic cooperation of thousands, sometimes millions, unrelated individuals, and this stands as an evolutionary puzzle: How could behaviors that help others have evolved if they provide a fitness advantage to the recipient(s) over the actor?

Humans display a large set of different manifestations of social behavior including generosity, competition, fairness, trust, and reciprocity to name a few. Each of them seems to have its own particularities and bio-psychological underpinnings (Fehr and Fischbacher, 2003; Ebstein et al., 2010; Corgnet et al., 2016; Espín et al., 2016a). However, while our species shows distinctive behavioral patterns in the social domain compared to other taxa, there is also large individual heterogeneity. Even though we

know that one part of the variation emanates from cultural differences (Henrich et al 2005, 2010; Herrmann et al., 2008), considerable heterogeneity still emerges within cultural groups. The objective of this study is to analyze the biological roots of such individual differences.

Given the relevance of social skills and associated behaviors for the evolutionary success of humans, one source of variation might indeed be biological. In fact, many studies—without relying on any particular biological trait—suggest that social behavior is genetically determined to some extent (Wallace et al., 2007; Cesarini et al., 2008, 2009; Ebstein et al., 2010). Along these lines, different biological and genetic factors at certain times of development might generate predispositions towards different social behaviors (Van Lange et al., 1997; Wingfield et al., 1998; Repetti et al., 2002; Fries et al., 2005). One of such factors may be associated with the amount of hormones individuals are exposed to during prenatal development (Knickmeyer et al., 2005; Auyeung et al., 2009; Berenbaum and Beltz, 2011). Fetal exposure to hormones such as androgens and cortisol is known to exert organizational effects on the human body and brain which may, in turn, influence behavior later in life (Baron-Cohen et al.; 2005; Cohen-Bedehan et al., 2005; Davis and Sandman, 2010; Lombardo e al., 2012). Since hormonal levels are under strong genetic influence (Harris et al., 1998; Bartels et al., 2003), this may represent one possible channel for the intergenerational transmission of behavior.

With regards to social behavior, sex hormones, and androgens in particular, have attracted considerable attention and there is now a plethora of studies on the behavioral correlates of circulating (either endogenous or administered) testosterone levels (Burnham, 2007; Zak et al., 2009; Zethraeus, 2009; Bos et al., 2010; Eisenegger et al. 2010, 2011, van Honk et al., 2012).

In this paper, rather than circulating hormones, we focus on the organizational effects of prenatal exposure to testosterone. More specifically, we explore the relationship between fetal testosterone exposure and social behavior in economic experiments. Previous studies have typically used the second-to-fourth digit ratio (2D:4D) as a putative marker of prenatal exposure to testosterone or, more precisely, of the relative exposure to testosterone compared to estradiol while in uterus (Lutchmaya et al., 2004). We also stick to this measure. Although direct evidence for the 2D:4D-fetal sex hormones link only exists for mice (Zheng and Cohn, 2011), rats (Talarovičová et al., 2009; Auger et al. 2013), and birds (Romano et al., 2005), there exists large indirect evidence and the ratio is commonly accepted as a proxy of fetal hormone exposure (also) in humans. 2D:4D is calculated such that lower ratios correspond to higher exposure to testosterone and lower exposure to estrogen. Consequently, males tend to display lower 2D:4D values than females (Manning, 2002). Many studies have analyzed the association between 2D:4D and diverse aspects of social involvement, ranging from status seeking (Manning and Fink, 2008) to positioning in social networks (Kovářík et al., 2017). Others have linked 2D:4D with certain diseases associated to decreased social skills, such as autism (see e.g. Felwah et al. 2015 and Manning et al. 2001).

Regarding the economic games designed to elicit (pro) social preferences, the literature has been inconclusive as to whether and how 2D:4D predicts subjects' social behavior.

Some studies report negative effects of fetal testosterone on behaviors such as generosity, cooperation, or trust (Cecchi and Duchoslav, 2018; de Neys et al., 2013), whereas others indicate positive effects on fair or normative behaviors (Millet and Dewitte, 2006, 2009; Van den Bergh and Dewitte, 2006). Null and non-linear relationships have also been frequently reported (Miller and de Witte, 2009; Sanchez-Pages and Turiegano, 2010, 2013; Brañas-Garza et al., 2013; Galizzi and Nieboer, 2015). It is worth noting that some of these papers are based on hypothetical decisions.

Moreover, several studies find 2D:4D-context interactive effects where situational cues change the relationship between 2D:4D and social behavior (Van den Bergh and Dewitte, 2006; Millet and Dewitte, 2009). It has been argued that—similarly to its circulating counterpart (Mazur and Booth, 1998; Eisenegger et al., 2011)—prenatal testosterone can be understood as a marker for social status (Millet, 2011). The evidence indeed suggests that the association between 2D:4D and specific traits is moderated by the context and its relation to status attainment. Low 2D:4D (reflecting *high* testosterone exposure) robustly predicts aggressive behavior only if status is at stake or if aggression is provoked, while many inconsistencies arise in neutral settings (Millet, 2011; Ryckmans et al., 2015). Furthermore, it seems that this association is more robust using real-life behaviors and outcomes, compared to hypothetical and lab environments (see Millet and Buehler, 2018, for an extensive discussion and review of the evidence). Similarly, Brañas-Garza et al. (in press) document a negative correlation between risk taking and 2D:4D only if the elicitation of risk attitudes is incentivized—and thus potentially relevant for status attainment—but not in a hypothetical task. Millet and Buehler (2018) provide a direct test of the moderating effect of a status-related framing and find strong evidence supporting this hypothesis. These examples are in line with the status- or dominance-related interpretation of the 2D:4D-behavior linkage (Millet, 2011). This interpretation brings the argument that fetal testosterone mainly manifests itself through enhancing the sensitivity to its circulating counterpart, supported by the observation that administered testosterone only affects low 2D:4D individuals (Buskens et al., 2016; Chen et al., 2016; see also Millet and Buehler, 2018). The role of circulating testosterone in status-related situations is widely documented (e.g. Burnham, 2007; Zak et al., 2009; Eisenegger et al., 2011).

As for prosocial behavior, the above discussion might explain the differing findings across studies but cannot predict whether status can be attained by acting more antisocially/aggressively or rather by being more prosocial/supportive, since both patterns may enhance status through different channels (Eisenegger et al., 2011; Boksem et al., 2013). In any case, these arguments clearly point to the need of exploring potential interactions of 2D:4D with contextual factors (Millet, 2011).

In this respect, the literature typically relies on the study of cues that *objectively* predict whether the decision-making context is relevant for status or not—such as, for instance, sexual cues in Van den Berg and Dewitte (2006), an important vs. non-important race in Millet and Buehler (2018), or the payment-relevant vs. hypothetical choices in Brañas-Garza et al. (in press). The interpretation is thus that status-relevant contexts activate status-seeking behaviors, which are more prevalent among low 2D:4D individuals (Millet, 2011).

This paper tackles the question of whether the association between 2D:4D and behavioral traits can be moderated by purely *subjective* measures of "context". More specifically, we hypothesized that a need for status should be more evident for individuals with low subjective wellbeing, who seek status for the sake of increasing their wellbeing. Previous studies suggest that individuals reporting lower wellbeing scores tend to be in lower social-status positions (Twenge and Campbell, 2002; Anderson et al. 2012; Morelli et al., 2017), to be more sensitive to unsolicited social comparison information (Lyubomirsky and Ross, 1997) and more envious or "competitive" in both self-reports and economic games (Charness and Grosskopf, 2001; Espín et al., 2016b; Verduyn et al., 2016). Similarly, depression has been associated to (unfavorable) social comparison and envy (Appel et al., 2016). There also exist evidence suggesting a (probably bi-directional) positive relationship between wellbeing and prosocial behavior (Konow and Earley, 2008; Zilioli et al., 2015; Espín et al., 2016b; Lane, 2017).

Thus, our hypothesis is that the goal of achieving status during social interactions should be more important for individuals with low subjective wellbeing (see Hypotheses section). This entails that the relationship between 2D:4D, as a marker for status-related traits, and social behavior should emerge more strongly among "unhappy" individuals. The direction of such relationship, however, is *ex-ante* unclear. As mentioned, prosocial behavior might either increase or decrease status (Bos et al., 2010; Eisenegger et al., 2010, 2011; Millet, 2011; van Honk et al., 2012). Moreover, it might be that different social behaviors produce different associations with 2D:4D. We therefore examine our hypothesis on five different behavioral measures covering five theoretically-relevant aspects of (pro)sociality.

The Results section first provides a systematic analysis of the association between 2D:4D and social behavior, and then tests how this association interacts with subjects' reported wellbeing. Three features of this study distinguish it from previous research. First, we use a (comparatively) large sample size that permits for high statistical power. Our sample consists of a total of 560 Caucasian individuals. This means that we will be able to find a small effect size (specifically, $r = 0.12$) with 80% power and $\alpha = 0.05$. Among the existing economic experiments similar to ours, which effectively measure the participants' fingers length rather than relying on self-reports, the largest Caucasian sample is that in Galizzi and Nieboer (2015) with a total of 201 Caucasians within an ethnically diverse sample of 602 individuals.

Second, we elicit five dimensions of social behavior using three economic games. All our participants decided, in random order, as Dictators in the Dictator Game (Forsythe et al., 1994), as both Proposers and Responders in the Ultimatum Game (Güth et al., 1982), and as both Trustors and Trustees in the Trust Game (Berg et al., 1995; see Methods). For each subject, we thus gathered measures in the domains of generosity (Dictator Game), bargaining (Ultimatum Game) and trust (Trust Game).

Finally, our dataset allows us to control for a number of potential confounding factors, such as, for instance, cognitive reflection (Bosch-Domènech et al., 2014; Cueva et al., 2016) or risk preferences (Brañas-Garza and Rustichini, 2011; Brañas-Garza et al., in press).

Regarding our research question, the available information includes individual measures of subjective wellbeing enabling us to test our hypothesis that "context" can also have an essentially subjective nature. In particular, we employ two widely-used measures of subjective wellbeing: *life satisfaction*, related to "evaluative" or "cognitive" wellbeing, and *self-esteem*, related to "eudaimonic" or "psychological" wellbeing (see Methods).

Our results show no robust association between 2D:4D and behavior in any of the five indicators of prosociality if we abstract from any conditioner: generosity, bargaining and trust-related behaviors are correlated neither linearly nor non-linearly with 2D:4D, and this holds for both males and females and left- and right-hands. At the first sight, these results support the evidence that prenatal exposure to *sexual hormones do not systematically predict social attitudes* in humans.

This null result notwithstanding, once we take subjective wellbeing into account, we document *positive* associations of 2D:4D with generosity in the Dictator Game (for both males and females) and trust and reciprocity in the Trust Game (only for males) among subjects reporting low wellbeing. In sharp contrast, this relationship disappears and may slightly reverse for individuals with relatively high wellbeing ratings.

These observations corroborate that the inconsistent findings in the literature relating 2D:4D and prosociality may indeed be due to the classic omitted variable problem, as claimed by Millet (2011). However, in contrast to the existing context-dependent interpretation, we show that context and whether context is status-relevant can have a purely subjective meaning (see Discussion).

METHODS

Participants and general protocol

In October 2011, all the first-year students (n=927) at the School of Economics of the University of Granada (Spain) were invited to participate in a survey/experiment at the EGEO Experimental Economics Lab. Participation was voluntary and the number of participants ended up being 659 (71% of the population), distributed in 27 sessions. Students were officially invited to visit the lab by the Dean of the School so that the original objective was *not* to earn money but to visit the lab, reducing potential self-selection issues with participants of laboratory economic experiments (Abeler and Nosenzo, 2015). We consider the participation rate of 71% very high. Once seated in their respective cubicles (which impeded visual contact between them), the students were invited to complete a survey and to play a variety of experimental games using a computer interface. None of those who showed up in the lab refused to participate. In the analysis below, we exclude from the sample individuals with missing values in any of the variables applied in this paper. To ensure ethnic homogeneity, non-Caucasian subjects were also excluded. The resulting sample size is 560 Caucasian subjects (230 males; age: mean ± SD = 17.97 ±1.82).

In each session, the participants were first asked to fill the socio-demographic and personality characteristics section, including self-reported measures of life satisfaction, self-esteem, risk preferences, and trust in others. In addition, the survey contained a

math test with four simple questions. After the survey, the subjects were explained in detail all the economic games they would face and then played all the games in a random order (24 different orders). Once finished with the computerized part, the subjects participated in a paper-and-pencil version of the Cognitive Reflection Test (Frederick, 2005). No time pressure was imposed in any of the stages. In what follows, we explain in detail the elicitation and the structure of our three main variable types.

2D:4D measurement

At the end of each session, the participants were scanned their both hands using a high-resolution scanner (Canon Slide 90). The lengths of the index and ring fingers were measured from the scanned images as the distance from the middle of the basal crease to the tip of the finger using Photoshop (see Neyse and Branas, 2014). Computer-assisted measurements of 2D:4D from scanned pictures have been found to be more precise and reliable than measurements using other methods (Allaway et al., 2009; Kemper and Schwerdtfeger, 2009). The 2D:4D of each hand was measured twice at an interval of one month by the same experienced researcher (not involved in this paper). These measurements displayed a high repeatability (right hand: intraclass correlation coefficient (ICC) = 0.9566, $p < 0.001$, left hand: ICC = 0.9440, $p < 0.001$) and were averaged to obtain a single value of the 2D:4D ratio for each hand. As expected, the left-hand and right-hand 2D:4Ds were correlated within individuals ($r = 0.67$, $p=0.000$ for males; $r =0.71$, $p=0.000$ for females; Pearson correlation) and males displayed lower 2D:4D than females (right hand means: $2D:4D_M =0.960$, $2D:4D_F =0.972$, $p=0.000$; left hand means: $2D:4D_M =0.965$, $2D:4D_F =0.976$, $p=0.000$; t-test).

Social behavior measurement - Economic games

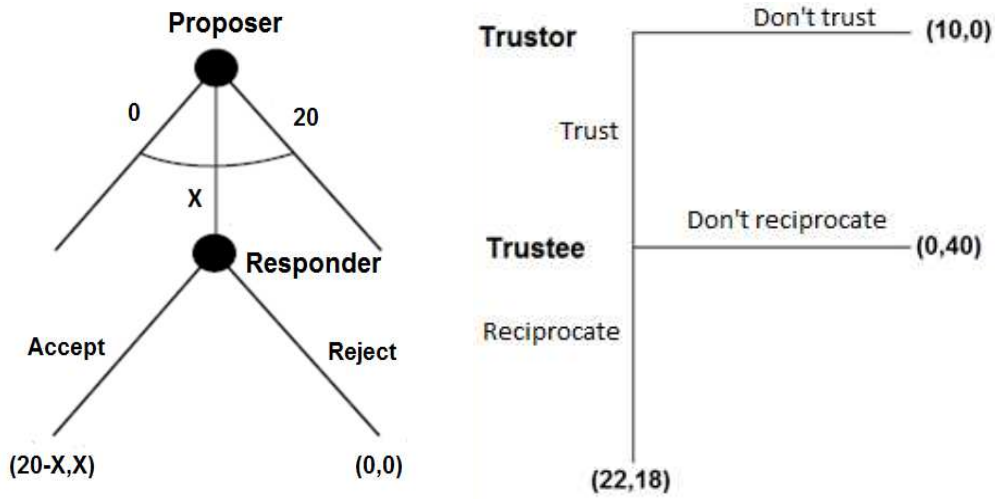
Our experiment consists of three canonical two-person games: the Dictator Game (DG, henceforth), the Ultimatum Game (UG), and the Trust Game (TG). The games were faced by each participant in random order and all participants played both roles in each game. For each decision, participants would be matched with a different anonymous individual selected at random among the other participants.

In the DG, one player, the Dictator, had to propose a division of €20 between herself and another anonymous participant, the Receiver, who could not but accept the proposed division. In our experiment, subjects were only allowed to propose the split in €2 increments. Below, we employ the amount of money donated to the other participant (*DG offer*) as a measure of generosity. Even though no subject played the role of the Receiver for obvious reasons, they could actually have been paid for this role if selected to make sure that Dictators' decisions affect others.

In the UG (Güth et al., 1982; see Figure 1), one player, the Proposer, had to propose a division of €20 between herself and another anonymous participant, the Responder, who—in contrast to the DG—could either accept or reject the proposal. If the latter accepted, the proposed division was implemented; in case of rejection, neither participant earned anything. Each subject participated in both roles. The *offer* made to the Responder will be our measure of Proposers' bargaining behavior. For the role of Responder, we used the strategy method: each subject had to state her willingness to accept or reject each of the possible proposals without knowing the offer of the

Proposer. Below, we employ the minimum acceptable offer (*mao*, thereafter)—the minimum amount of money that a subject would accept—as our measure of Responders' behavior. Such approach is common in the literature and the *mao* is typically interpreted as indicative for the Responder's willingness to punish the Proposer at a personal cost (e.g. Fehr and Fischbacher, 2003; Henrich et al., 2005; Burnham 2007; Brañas-Garza et al., 2014).

Figure 1. Ultimatum (left) and Trust (right) Games in strategic form implemented in our study. The figure shows the payments (in €) associated to each of the possible outcomes for the Proposer (Trustor) first and Responder (Trustee) second in the Ultimatum (Trust) Game. The Dictator Game only differs from the Ultimatum Game in that the rejection option does not exist in the second stage and the payoffs consequently are (20-X,X).



As for the TG, we employ a binary version of the game (Ermisch et al., 2009) and again resort to the strategy method. More precisely, one player, the Trustor, had to decide whether to pass €10 or €0 to the Trustee. If she passed €0, the Trustor earned €10 and the Trustee nothing; if she rather passed €10 (i.e., the Trustor trusted the Trustee), the latter would receive 4 × €10 = €40. In such a case, the Trustee had to decide whether to either send back €22 and keep €18 for herself (that is, being trustworthy) or keep all €40 without sending anything back, in which case the Trustor would not earn anything. The Trustor's decision thus measures trust, whereas the Trustee's decision measures positive reciprocity. Figure 1 displays the extensive form of the TG implemented. In the analysis below, *TG trust=1* if the participant chose to pass the money to the Trustee and 0 otherwise. Similarly, *TG reciprocity=1* if as a Trustee the participant chose to return the money to the Trustor and 0 otherwise.

Decisions were not hypothetical. Participants' payoffs were computed according to their decisions in the games and/or those of a randomly matched participant. The identity of the other player remained anonymous. One of every ten participants was randomly selected to be paid, and the final payoff was determined by a randomly selected role.

The average earnings of those selected for payment, including those winning €0 (11.43%), were €10.43.

Additional variables

As noted before, we administered all participants a survey eliciting a large amount of information (including *gender*, *age*, *household income* and *social capital*). We measured participants' subjective well-being through the *life satisfaction* question: "*In a scale from 1 to 7, where 1 means 'completely unsatisfied' and 7 means 'completely satisfied', in general, how satisfied are you with your life?*".

As a second measure of subjective wellbeing, we focus on *self-esteem*, which is considered a fundamental component of long-term wellbeing, also referred to as eudaimonia. In particular, we combine four measures of self-esteem[1] into one single variable by gender (Cronbach's alpha = 0.76 for males, Cronbach's alpha = 0.81 for females) using factor analysis as in Espín et al. (2016b).

While *life satisfaction* ratings cover what has been termed as "evaluative" or "cognitive" wellbeing, eudaimonia or "psychological wellbeing" refers to a non-hedonic state of wellbeing that derives from factors such as self-determination, the realization of deeply-held values, and the development of meaning in life (Ryan and Deci, 2001; Sirgy, 2012). Although they assess different wellbeing constructs, these two types of measures are typically positively correlated (Sirgy, 2012; Espín et al., 2016b), as they are in our study (Spearman's rho =0.30, p =0.000). In addition, life satisfaction and self-esteem judgments have been observed to reflect to a large extent the momentary affective state (Schwarz and Clore, 1983; Schwarz et al., 1987; Suh et al. 1998; Sirgy 2012).

In addition, we also control for two measures of cognitive functioning. The first one is given by the number of correct responses in a simple *math* skills test (from 0 to 4). The second one measures the participants' tendency to *reflect* on their first intuition (i.e., their cognitive style, intuitive vs. reflective) and is given by the number of correct answers (from 0 to 3) in the Cognitive Reflection Test (Frederick, 2005). Cognitive skills and cognitive styles have been previously related to both social behaviors (Burks et al. 2009; Corgnet et al., 2015, 2016; Al-Ubaydli et al., 2016; Cabrales et al., 2017; Capraro et al., 2017) and 2D:4D (Brañas-Garza and Rustichini, 2011; Bosch-Domènech et al., 2014; Cueva et al., 2017) and thus represent potential confounding factors.

Finally, our battery of controls includes three measures for participants' *risk attitudes* obtained from a series of binary decisions involving (hypothetical) monetary lotteries. Risk attitudes may correlate with both social behavior (Bohnet and Zeckhauser, 2004;

[1] The question was as follows: "At this point, you have to answer if you agree or disagree with the following statements on a scale between 1 and 7 like the one on the card. 1 means that you completely disagree and 7 means that you completely agree while 4 is the neutral point.

- I think I am a valuable person, at least in comparison with others. (self-esteem 1)
- I think I have many good characteristics. (self-esteem 2)
- I am capable of doing things as well as other people do. (self-esteem 3)
- I have a positive attitude towards myself. (self-esteem 4)"

Corgnet et al., 2016) and 2D:4D (e.g. Brañas-Garza and Rustichini, 2011; Brañas-Garza et al., in press).

Econometric analysis

We first run a series of regression models. Our five social behavior measures (*DG offer*, *UG offer*, *UG mao*, *TG trust,* and *TG reciprocity*) are regressed on 2D:4D, 2D:4D-squared (*2D:4D-sq*), and gender (because 2D:4D is sexually dimorphic), as well as their interactions. All regressions control for order effects and are conducted both with and without control variables and for both the left- and right-hand 2D:4D. The control variables are *age*, *income*, *life satisfaction*, *social capital*, *math*, *reflection*, and *risk attitudes*. We use OLS regressions for *DG offer*, *UG offer,* and *UG mao*, and logistic regressions for *TG trust* and *TG reciprocity*.

In the second part, in line with the recent literature arguing for the context-specific effects of 2D:4D (Millet, 2011; Millet and Buehler, 2018), a set of regression models test for the interaction between 2D:4D and the variables measuring the individuals' subjective wellbeing. We rely on the *life satisfaction* measure for the main analyses and then use *self-esteem* for robustness checks in the supplementary materials. Both variables are standardized for the gender-specific sample. In this analysis, we focus on the linear relationship between 2D:4D and the variable of interest and run separate regressions for males and females in order to obtain a more detailed picture.

The analysis was performed using Stata/SE 15.1 (StataCorp).

Ethics Statement

All participants were informed about the content of the experiment before they participated and provided written consent. Besides, their anonymity was always preserved (in agreement with the Spanish Law 15/1999 for Personal Data Protection) by assigning them a random numerical code, which would identify them in the system. No association was ever made between their real names and the results. As it is standard in socio-economic experiments, no ethic concerns are involved other than preserving the anonymity of participants. This procedure was checked and approved by the Vice dean of Research of the School of Economics of the University of Granada, the institution hosting the experiment.

HYPOTHESES

2D:4D-social behavior link (main effects). The literature is largely inconsistent as to whether and how 2D:4D correlates with prosocial behavior in the economic games studied here. Disregarding any contextual or methodological differences between and within studies, there are studies reporting positive (van den Berg and Dewitte, 2006; Millet and Dewitte, 2009; Ronay and Galinsky, 2011; Buser, 2012; de Neys et al. 2013), negative (van den Berg and Dewitte, 2006; Millet and Dewitte, 2009; Buser, 2012), and non-monotonic (Millet and Dewitte, 2006; Brañas-Garza et al., 2013; Galizzi and Nieboer 2015; Brañas-Garza et al. 2013) associations between the two traits. In sum, the existing evidence provides no specific hypothesis regarding how 2D:4D organizes

prosocial behavior in our economic games as the findings are mixed even within games and within studies.

"Context"-dependent 2D:4D-social behavior link. Even though the above discussed literature differs in many aspects—such as 2D:4D measurement, subjects' incentives, and games analyzed—one pattern emerges: providing specific contextual cues affects and can even reverse the association between 2D:4D and behavior (Millet, 2011). For example, Van den Berg and Dewitte (2006) observe that lower 2D:4D either increases or decreases rejection rates in the UG depending on whether subjects are in a neutral or sex-related context, respectively. Millet and Dewitte (2009) detect either a negative or positive association between 2D:4D and giving in DGs, depending on whether participants are primed with cues of aggression or not. Millet and Dewitte (2007) report a negative relationship between 2D:4D and aggression only after exposure to aggressive music videos. Similarly, Ronay and Galinsky (2011) conclude that the ability of 2D:4D to predict retaliation behavior requires certain provocation. In addition, 2D:4D seems to be more consistently related to traits and behaviors in real-life settings than artificial lab environments or hypothetical situations (Millet and Buehler, 2018) and a relationship may only appear in the lab if monetary incentives are provided (Brañas-Garza et al., in press). In our neutral setting without priming status, dominance, or any competition but in which all tasks are incentivized, neither (pro)sociality nor selfishness is *ex ante* status-enhancing and we expect little relation between 2D:4D and behavior. Rather, we expect our subjects to exhibit a subjective interpretation of the situation and hypothesize that the relationship will depend on whether subjects feel in need of status, as proxied by their wellbeing self-reports. In other words, we expect subjective wellbeing to moderate the association between 2D:4D and behavior in our games and, more specifically, that the effect of 2D:4D on social behavior will be mainly observable among individuals reporting low wellbeing ratings.

Needless to say, 2D:4D is sexually dimorphic and the relation between 2D:4D and behavioral traits is commonly gender-specific (Auyeung et al., 2009). Moreover, the adherence to sharing rules in function of the environment may differ across men and women (Croson and Gneezy, 2009; Espinosa and Kovářík, 2015) and testosterone affects men and women asymmetrically (Zethraeus et al., 2009; Eisenegger et al., 2010). Hence, the relationships between 2D:4D and behavior and their interaction with our moderator variables may well differ across genders.

RESULTS I: 2D:4D AND SOCIAL BEHAVIOR IN ECONOMIC GAMES

Tables 1 – 5 report the estimates of a series of models in which we regress the behavior in a particular role in a particular game on all the combinations of 2D:4D, 2D:4D-squared, and a gender dummy (including interactions of the two former measures with the latter). The models are conducted both with and without control variables and for the left and right hands separately.

This exercise provides a clear message: 2D:4D is not systematically related to the subjects' behavior in any economic game under scrutiny. There does not appear to be any single significant main effect of 2D:4D on behavior in the DG or UG in any of the models. In the regressions estimating *TG trust*, a significant quadratic inverted-U shape

effect of 2D:4D appears for the left hand among females, but it becomes marginally significant when control variables are included. The interaction between 2D:4D (or 2D:4D-sq) and gender tends to be non-significant as well (except for a marginally significant positive interaction on *TG reciprocity* when using the right hand). This indicates that the effects of 2D:4D do not depend on gender and the null results hold for both males and females.

Table 1. DG offer as a function of 2D:4D

					RIGHT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	6.54*	5.72	-130.90	-121.70	2.80	1.93	-219.60	-216.70
Male	-0.00	0.00	-0.01	-0.01	-8.92	-8.91	-59.78	-62.82
$2D:4D^2$			70.69	65.54			114.00	111.90
2D:4D *Male					9.25	9.25	112.40	118.60
$2D:4D^2$*Male							-52.21	-55.41
					LEFT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	6.47	5.78	-124.20	-145.20	1.04	0.29	-204.00	-185.80
Male	-0.02	-0.00	-0.02	-0.01	-13.12	-13.19	-48.73	0.94
$2D:4D^2$			67.15	77.59			105.10	95.41
2D:4D *Male					13.53	13.61	85.78	-16.76
$2D:4D^2$*Male							-36.61	16.27
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Estimates of OLS regressions. *** p<0.01, ** p<0.05, * p<0.1

Table 2. UG offer as a function of 2D:4D

					RIGHT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-0.94	-0.75	106.40	99.48	-1.54	-1.42	58.46	48.61
Male	0.13	0.11	0.13	0.12	-1.33	-1.47	-59.39	-61.47
$2D:4D^2$			-55.20	-51.56			-30.76	-25.63
2D:4D *Male					1.50	1.63	122.50	126.60
$2D:4D^2$*Male							-62.95	-64.97
					LEFT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-0.95	-0.90	19.00	31.33	-2.76	-3.01	-79.18	-62.34
Male	0.13	0.11	0.13	0.11	-4.27	-4.97	-108.80	-99.73
$2D:4D^2$			-10.25	-16.57			39.17	30.41
2D:4D *Male					4.54	5.24	219.90	200.60
$2D:4D^2$*Male							-110.90	-100.60
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Estimates of OLS regressions. *** p<0.01, ** p<0.05, * p<0.1

Table 3. UG MAO as a function of 2D:4D

					RIGHT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-1.77	-1.80	-40.74	-37.51	-3.50	-3.28	-62.80	-44.71
Male	-0.22	0.03	-0.22	0.03	-4.35	-3.48	-5.82	11.73
$2D:4D^2$			20.05	18.37			30.39	21.22
2D:4D *Male					4.29	3.64	6.72	-28.34
$2D:4D^2$*Male							-0.95	16.79
					LEFT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-1.05	-1.11	-174.90	-185.50	0.61	0.73	-181.40	-166.70
Male	-0.21	0.04	-0.21	0.04	3.81	4.48	-19.03	11.82
$2D:4D^2$			89.38	94.76			93.34	85.84
2D:4D *Male					-4.15	-4.58	41.91	-20.78
$2D:4D^2$*Male							-23.18	8.89
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Estimates of OLS regressions. *** p<0.01, ** p<0.05, * p<0.1

Table 4. TG trust as a function of 2D:4D

					RIGHT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	1.70	0.88	-33.30	-31.12	2.20	1.49	-50.69	-50.11
Male	0.30	0.12	0.29	0.12	1.56	1.66	-27.47	-32.61
$2D:4D^2$			18.01	16.47			27.10	26.43
2D:4D *Male					-1.31	-1.60	58.34	68.95
$2D:4D^2$*Male							-30.61	-36.26
					LEFT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	-0.79	-1.63	198.80	182.90	0.41	-0.01	298.40**	292.20*
Male	0.27	0.09	0.27	0.09	3.60	4.27	128.00	137.60
$2D:4D^2$			-102.60	-94.81			-152.80**	-149.90*
2D:4D *Male					-3.44	-4.31	-258.70	-278.10
$2D:4D^2$*Male							130.80	140.40
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Estimates of logistic regressions. *** p<0.01, ** p<0.05, * p<0.1

Table 5. TG reciprocity as a function of 2D:4D

					RIGHT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	1.32	1.70	-128.70	-179.00	-2.81	-2.54	-179.50	-253.80
Male	0.13	0.05	0.12	0.03	-10.63*	-10.93*	60.16	59.75
$2D:4D^2$			66.93	92.97			90.32	128.30
2D:4D *Male					11.17*	11.42*	-140.40	-141.70
$2D:4D^2$*Male							81.01	82.69
					LEFT HAND			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2D:4D	2.02	2.18	-127.90	-156.50	-0.46	-0.89	-313.60	-355.00
Male	0.14	0.05	0.13	0.05	-6.50	-8.06	-191.90	-193.80
$2D:4D^2$			66.83	81.69			160.40	181.50
2D:4D *Male					6.86	8.39	387.80	389.70
$2D:4D^2$*Male							-195.40	-195.50
Controls	no	yes	no	yes	no	yes	no	yes
Observations	560	560	560	560	560	560	560	560

Estimates of logistic regressions. *** p<0.01, ** p<0.05, * p<0.1

RESULTS II: THE ROLE OF SUBJECTIVE "CONTEXT"

Here, we test whether subjective wellbeing interacts with 2D:4D to determine social behavior. Tables S1-S5 report the results for *life satisfaction*, disaggregated for men and women and left- and right-hand 2D:4D.

Compared to the previous null findings, the estimated impact of 2D:4D on behavior changes substantially. With the only exception of the UG, 2D:4D explains the behavior of subjects depending on their *life satisfaction*. The general pattern is that 2D:4D organizes the behavior of subjects with (self-reported) low *life satisfaction*, while there is no robust association between 2D:4D and behavior among satisfied participants (those with high satisfaction). The analysis using *self-esteem* as a measure of subjective wellbeing draws a similar picture (see Discussion). Therefore, we relegate the details to supplementary materials (see Tables S6-S10 and Figures S1-S5).

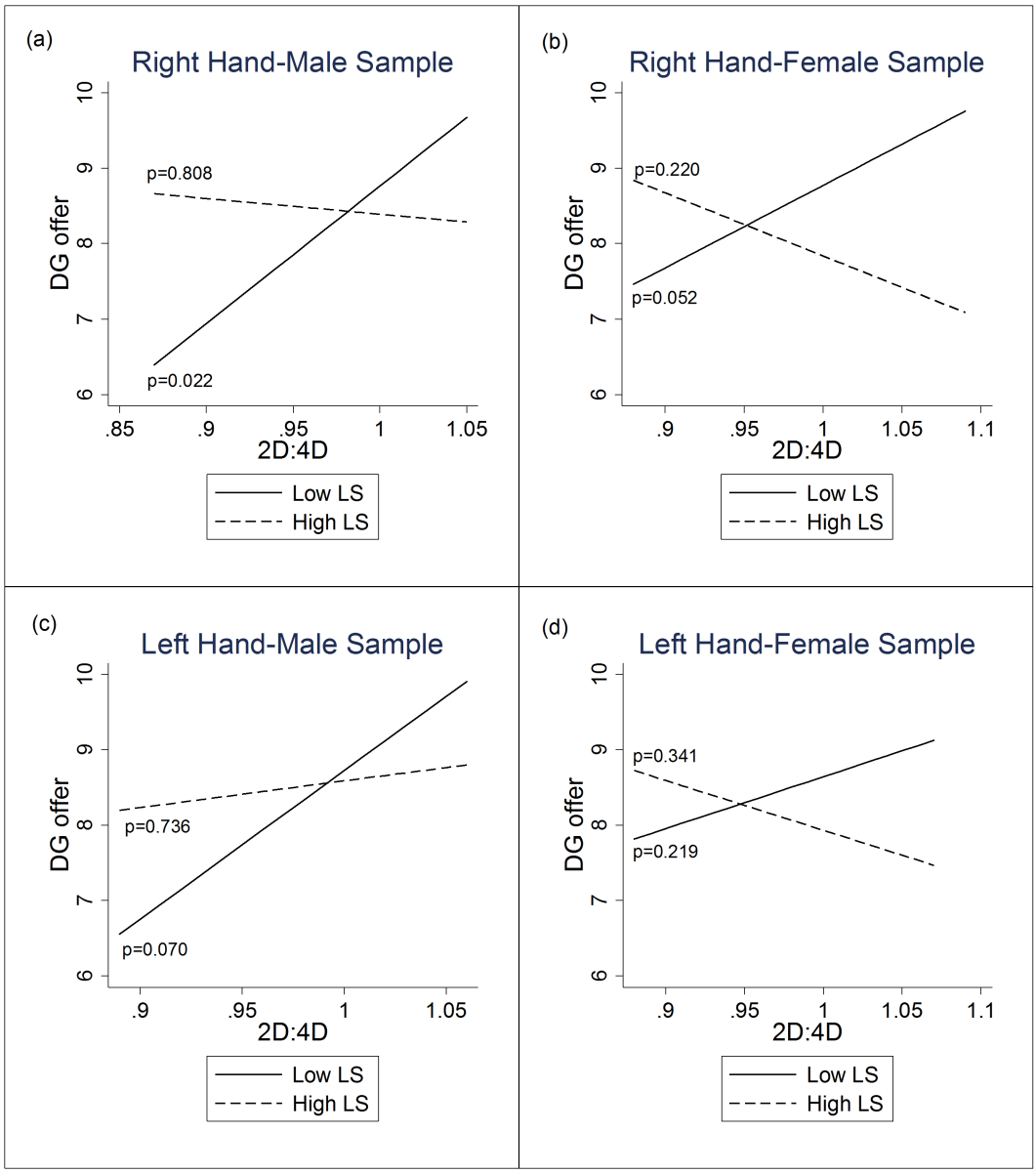
Dictator game

The association between 2D:4D and giving in the DG interacts negatively with *life satisfaction* for males using the right hand (p=0.039 without controls; p=0.071 with controls) and for females using both the right (p=0.026 without controls; p=0.028 with controls) and left hands (p=0.080 without controls; p=0.095 with controls); the pattern persists for male left hands but becomes non-significant at 10% (p=0.242 without controls; p=0.303 with controls).

According to Wald tests on the model estimates, both right- and left-hand 2D:4D's of men reporting one SD *below* the average *life satisfaction* in the male sample are significantly and positively related to *DG giving* (p=0.009 without controls, p=0.022 with controls for the right hand and p=0.049 without controls, p=0.070 with controls for the left hand), whereas the association is never significant for males scoring one SD *above* the average *life satisfaction* (p>0.658; see panels (a) and (c) in Figure 2). In case of women, the Wald tests show that the positive association between 2D:4D and giving for females with *life satisfaction* one SD below the mean is significant for the right hand (p=0.036 without controls; p=0.052 with controls) but it does not reach significance for the left hand (p=0.137 without controls; p=0.219 with controls). For women self-reporting life satisfaction one SD above the mean, the 2D:4D is never significantly related to giving (p>0.341; see panels (b) and (d) in Figure 2).

In sum, the 2D:4D impacts positively the generosity of individuals reporting *low wellbeing* ratings, an effect apparently weaker for females. In contrast, individuals reporting *high wellbeing* exhibit no systematic relationship between 2D:4D and giving.

Figure 2. Marginal effects on DG offer. Estimates from Wald tests on the coefficients from Table S1. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.



Ultimatum game

Regarding bargaining behavior in the UG, we observe no significant relationship between 2D:4D and individual decisions, independently of subjects' role (Proposer or Responder), life satisfaction, gender, and whether we employ the left or right hands (see Figures 3 and 4). There is only one exception: the left 2D:4D is positively but marginally related to *UG offer* for males with *life satisfaction* one SD above the average (see Figure 3(c), p=0.076 without controls, p=0.070 with controls).

Figure 3. Marginal effects on UG offer. Estimates from Wald tests on the coefficients from Table S2. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.

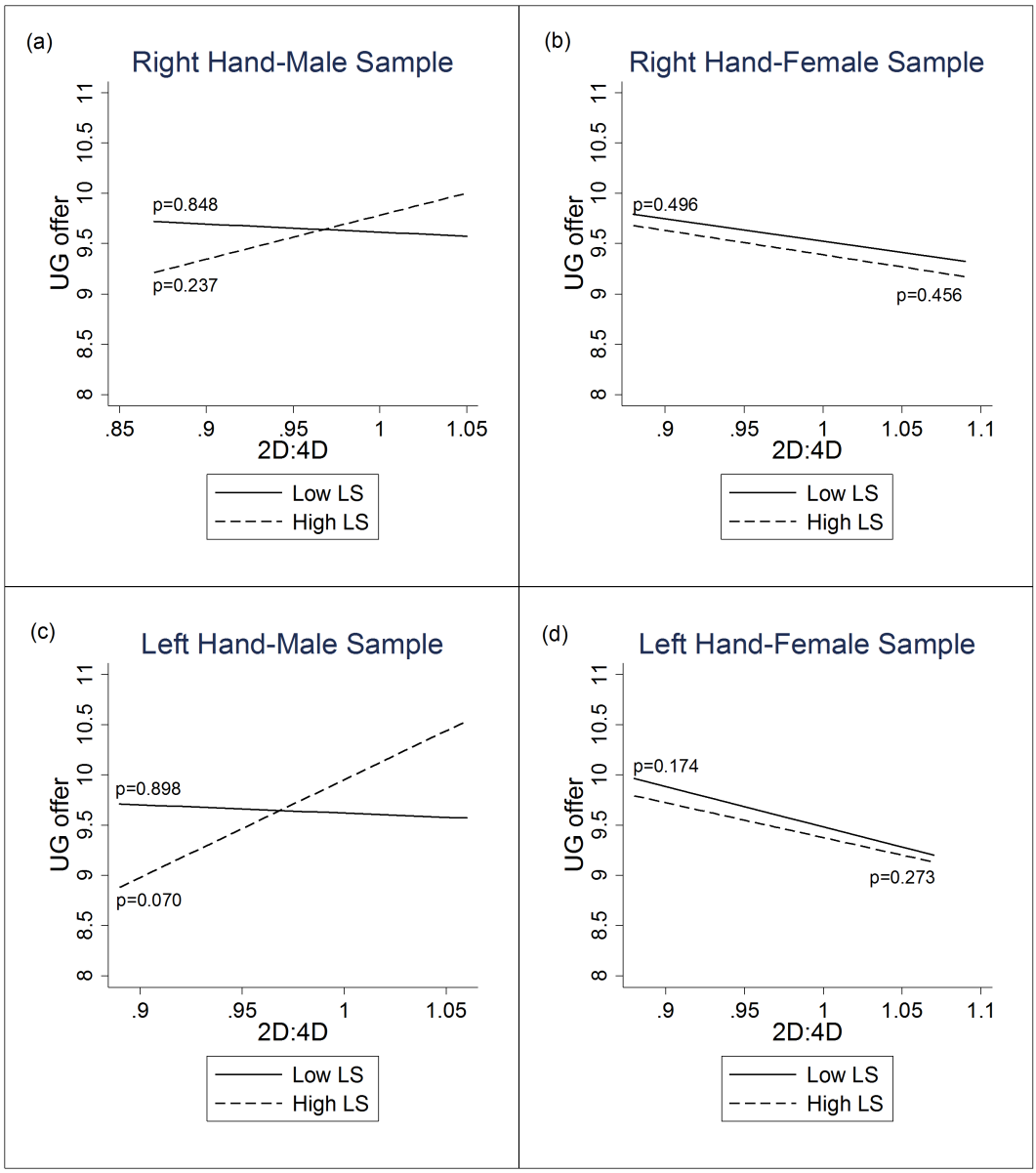
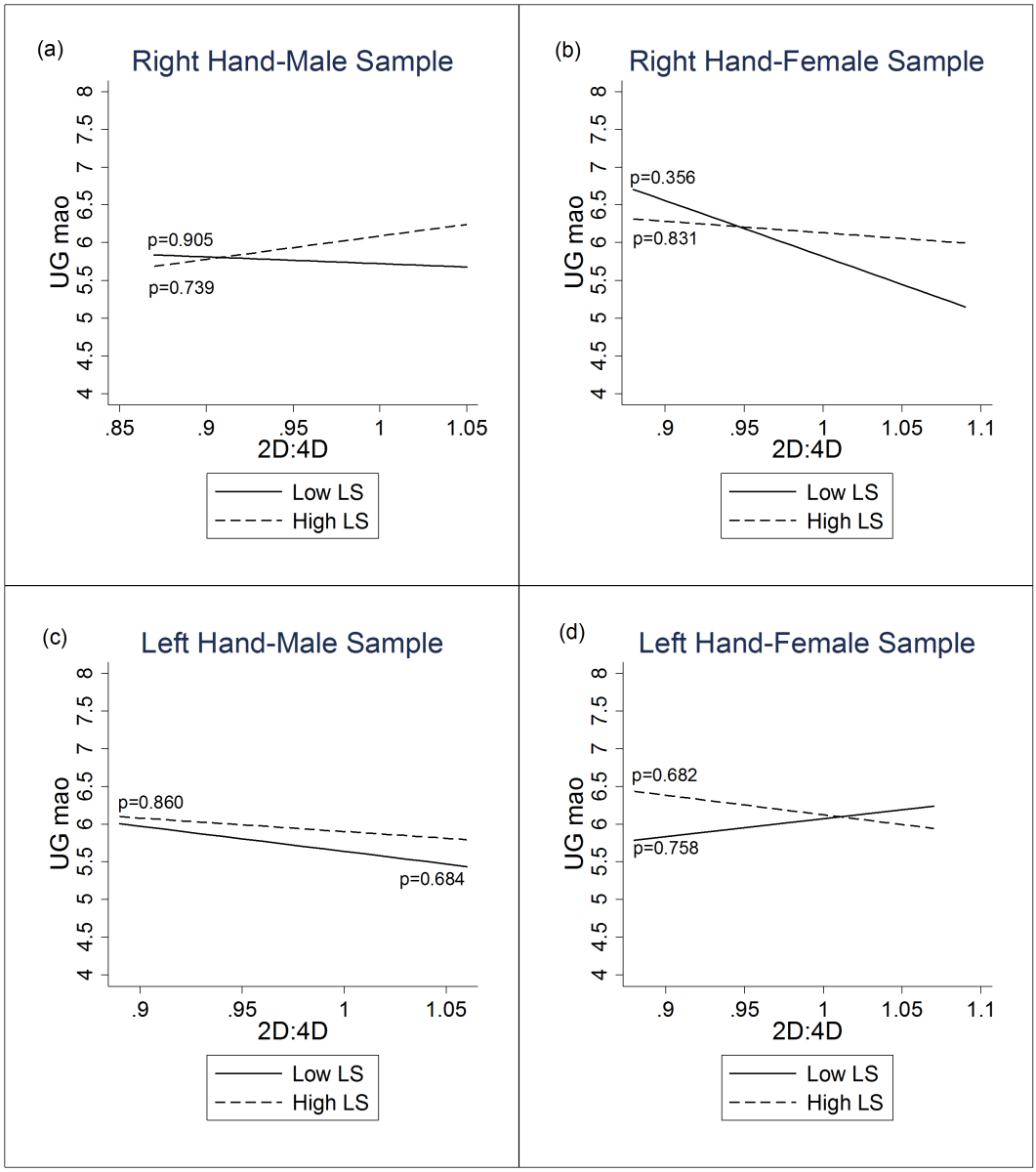


Figure 4. Marginal effects on UG MAO. Estimates from Wald tests on the coefficients from Table S3. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.

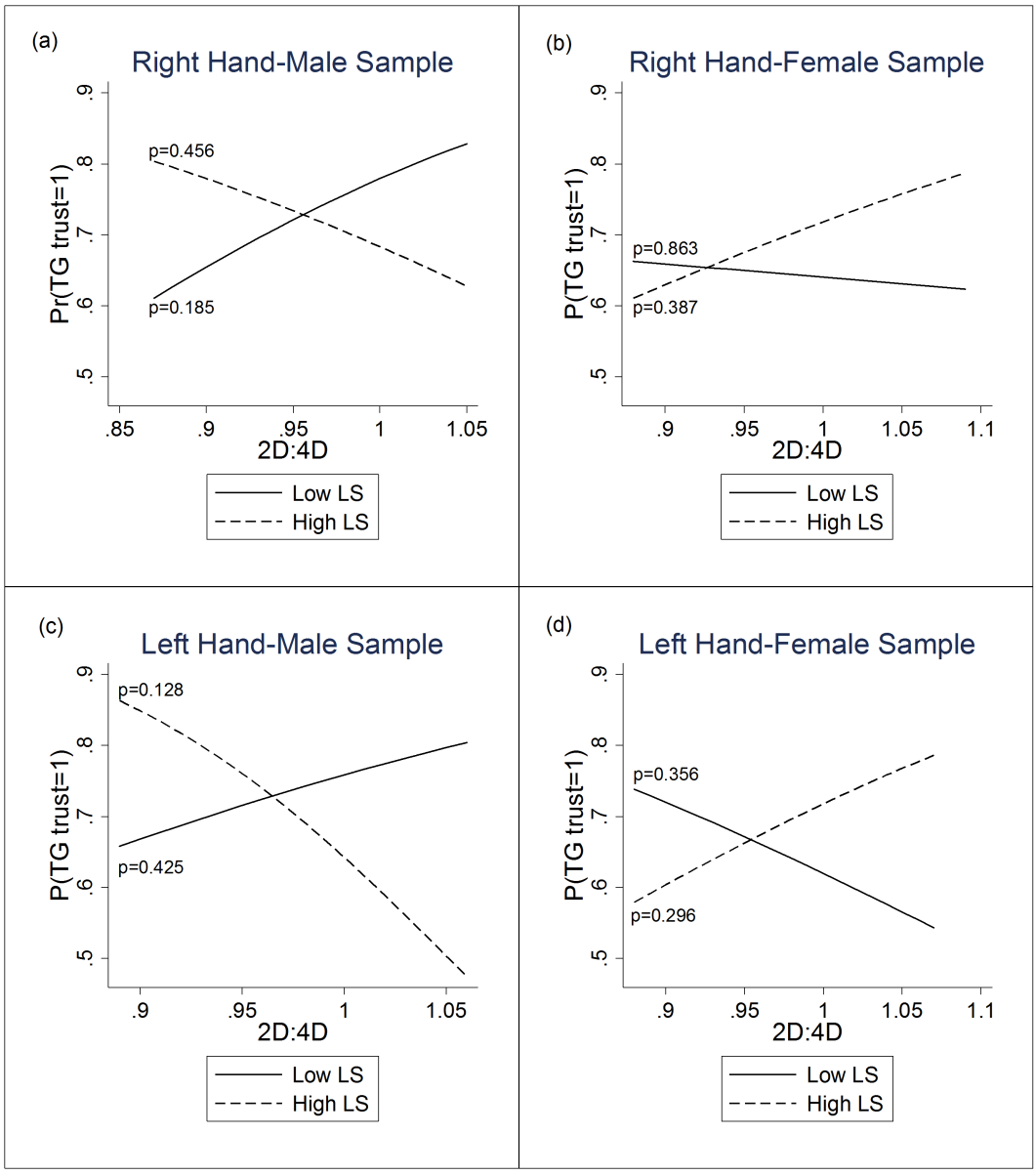


Trust game

The results for the TG mimic in some respects those of the DG: 2D:4D predicts positively trust and reciprocity for male subjects reporting low *life satisfaction* but not those of high-satisfaction individuals. Nevertheless, the effect only appears for men and is statistically weaker in this game. In particular, males exhibit a marginally significant negative impact of the interaction between 2D:4D and *life satisfaction* on *TG trust* for

both hands (p=0.078 without controls, p=0.089 with controls for the right hand and p=0.061 without controls, p=0.073 with controls for the left hand).

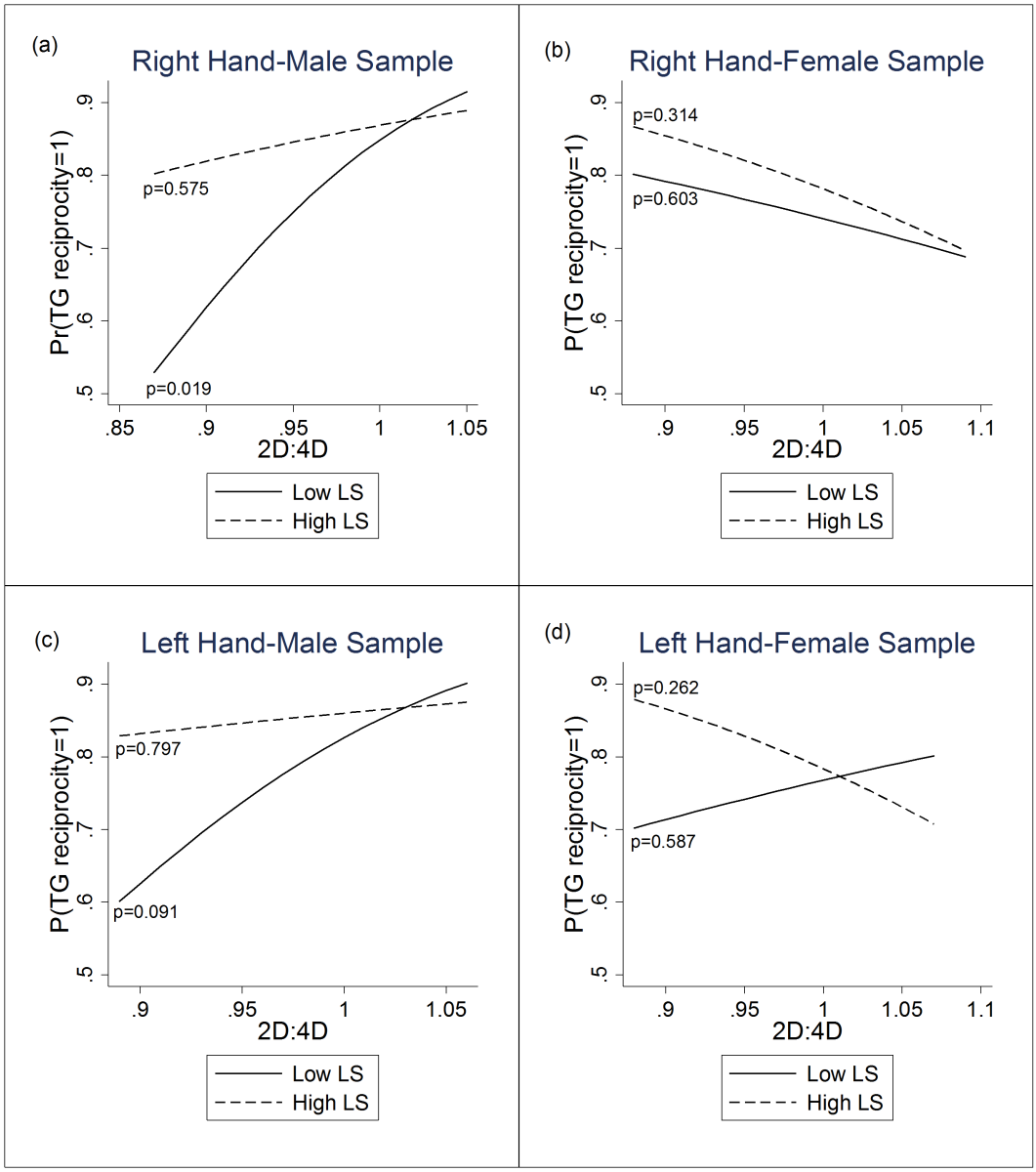
Figure 5. Marginal effects on TG trust. Estimates from Wald tests on the coefficients from Table S4. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.



Applying again the Wald test, we observe that the association between 2D:4D and trust is positive for male subjects reporting one SD below the average *life satisfaction*, but the effect does not reach significance (p=0.143 without controls, p=0.185 with controls for the right hand and p=0.374 without controls, p=0.425 with controls for the left hand). To reach significance at 10% level or less, we should go further to values of about 1.3-1.6 SD below the average *life satisfaction* (depending on the model). Observe in panels (a) and (b) of Figure 5 that the association actually reverses for males reporting high wellbeing, but again the effect is non-significant (p>0.128).

As for *TG reciprocity* (Trustees' behavior), the findings for males are similar to the *DG offer* and *TG trust*. Even though the interactions are not significant in Table S5 (p>0.110), Wald tests reveal that 2D:4D of both hands impacts positively and significantly the positive reciprocity of men reporting *life satisfaction* one SD below the average (p=0.017 without controls, p=0.019 with controls for the right hand and p=0.074 without controls, p=0.091 with controls for the left hand). In contrast, there exists no association between 2D:4D and *TG reciprocity* for males reporting *life satisfaction* one SD above the average (p>0.575). No effect is ever significant for females regarding their behavior in the TG. See Figure 6.

Figure 6. Marginal effects on TG reciprocity. Estimates from Wald tests on the coefficients from Table S5. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.



DISCUSSION

This article contributes to the recent literature promoting a context-dependent interpretation of the association between 2D:4D and behavioral traits and outcomes. We particularly observe that 2D:4D can predict three dimensions of prosocial behavior (generosity in the DG, and trust and positive reciprocity in the TG) among men reporting low life satisfaction ratings, while no systematic correlation exists in our data for men exhibiting high wellbeing. Among women, the result is only replicated for generosity in the DG.

These findings thus corroborate that the inconsistencies across studies regarding the link between 2D:4D and prosocial behavior might be due to differing contextual variables and not controlling for the context might generate omitted-variable issues (Millet, 2011). The particular contribution of the present study is that "context" can be individual-specific and highly subjective. Traditionally, contextual cues are objectively determined in the literature and common for all subjects, while wellbeing differs across subjects in function of their life experience and current moods in our study. Our results support the hypothesis that individuals with low wellbeing are in need for status and, therefore, social interactions are more likely to be perceived as status-relevant situations by them, compared to "happier" individuals. As a consequence, prenatal hormone exposure predicts behavior only among unsatisfied individuals. In particular, given the positive relationship between 2D:4D and prosociality, it can be inferred from our results that individuals perceive that they can increase their status by being *less* prosocial in the DG and TG.

Therefore, *low-wellbeing low-2D:4D participants might see the experiment as an opportunity to build status* while those who feel highly satisfied feel no urge to pursue it. There are several pieces of evidence supporting this hypothesis. Perceived wellbeing seems to be predicted by real-life status. For instance, life satisfaction and self-esteem are partially determined by one's status especially during young adulthood, the age range of our participants (Twenge and Campbell, 2002). Similarly, Morelli et al. (2017) report that people satisfied with their life occupy central positions in their network neighborhoods, an indicator of social status (Lin, 1999). This evidence thus suggests that people with high wellbeing ratings already enjoy high status in real life and our context-free, neutral experiment does not stimulate them in any direction. The opposite is true for those feeling unsatisfied with their life, who do not enjoy high status outside the lab. If the proposed explanation is correct, then people try to attain status by being less prosocial. This is in line with the evidence in Millet and Dewitte (2009).

Applying a different measure of wellbeing, namely self-esteem, yields qualitatively similar results albeit somehow weaker in the DG. As can be seen in Figures S1-S5, although the positive effect of 2D:4D on DG generosity among low self-esteem individuals becomes non-significant (or marginally significant) for both males and females, the positive effects of 2D:4D on both trust and positive reciprocity in the TG persist and are often slightly stronger among low self-esteem males (compared to low life satisfaction).

It is true that the effects are in general not very strong, especially the 2D:4D-wellbeing interaction effect. Note that our measures of wellbeing do not refer to "emotional" wellbeing or affect. Since both life satisfaction and self-esteem are known to partially reflect the individual momentary affect (Schwarz and Clore, 1983; Schwarz et al., 1987; Suh et al. 1998; Sirgy, 2012), it might be that the true effect is driven by momentary affect rather than the less emotional life satisfaction and self-esteem evaluations. This would explain why we find consistent significant effects but they are typically not strong. Future research should explore this possibility in greater detail by measuring individuals' positive and negative affect during the experiment. In fact, life satisfaction is correlated negatively with depression, anger, and stress and positively with joy, pride, and cheer among other mood states (Suh et al., 1998; Extremera and Fernández-Berrocal, 2005; Kuppens et al., 2008; Extremera et al., 2009). And momentary affect is known to be correlated with the release and influence of hormones such as testosterone, serotonin, or cortisol (O'Connor et al., 1989; Smyth et al., 1989; Owens and Nemeroff, 1994; van Eck et al., 1996; Barrett-Connor et al., 1999; Pope et al., 2000; Amin et al., 2005).

Along these lines, our results also partially support the claims that exposure to fetal hormones affects behavior through a second channel: the increased sensitivity to circulating testosterone of low 2D:4D people (Manning et al., 2014). For instance, recent papers (Buskens et al., 2016; Chen et al., 2016) show that administered testosterone, which is known to stimulate dominance-related behaviors (Mazur and Booth, 1998), only affects the behavior of low 2D:4D individuals.

The present evidence raises two questions though. Why do these results seem more evident for men than women and why do they exist in case of the DG and TG, but not in the UG? Gender-specific relationships are commonplace in the 2D:4D literature. For instance, Brañas-Garza and Rustichini (2011) find risk attitudes to be determined by 2D:4D for men but not women, or Kovářík et al (2017) report that low-2D:4D men are more likely to be globally central in networks while low-2D:4D women are more prone to be popular. Auyeung et al. (2009) show that such gender-specific associations already appear at early ages. It is very likely that status is reached differently for each gender, and status attainment is moderated by different variables for women compared to men.

As for the lack of results in the UG, we can only speculate. It is generally agreed that the behavior in the UG may confound prosocial attitudes with purely strategic concerns: Proposers' "generosity" is to a large extent explained by the anticipation to responders' behavior (see for instance Brañas-Garza et al., 2017). On the other hand, Responder's high MAOs are also known to reflect either "antisocial" or "prosocial" punishment (Brañas-Garza et al., 2014). In any case, if status were associated by our subjects with the avoidance of falling below others, we should have observed a negative relationship between MAO and 2D:4D among individuals reporting low wellbeing, but this is not the case. Put differently, it might be that status in our experiments is more related to making others fall below oneself (Charness and Grosskopf, 2001) than to avoiding falling below others. In fact, among individuals reporting low wellbeing, the behavior of low 2D:4Ds (vs. high 2D:4Ds) tends to make the other player to end up with less money than them in both the DG and the TG. That the effect seems to be sharper in the DG

supports this interpretation, since it is the decision in which only purely distributional concerns are present, free of strategic (also present in the TG trust because one may increase earnings by trusting) or reciprocal (TG reciprocity) considerations. Generosity (or pure "altruism") may indeed also influence both trust and reciprocity decisions in the TG (e.g. Espín et al., 2016a). As an additional test, we checked whether the effects of 2D:4D observed in the TG for males survive after controlling for DG generosity (which in our sample is in fact positively related to both trust and reciprocity in the TG): some significant effects persist but in general they are about 10-30% smaller. This lends further support to the conjecture that it is making others fall below oneself, beyond strategic or reciprocal concerns, that is perceived by our subjects as the status-increasing strategy. A more systematic analysis of this hypothesis is left for future research.

To conclude, this paper contributes to the context-dependent interpretation of the association between 2D:4D and behavior by enlarging the definition of context: we use a subjective, self-reported version of "context". That is, rather than claiming that prenatal testosterone exposure plays a role when contextual cues suggest that status is at stake, we argue that it might also play a role for individuals who *perceive* their status to be at stake.

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SUPPLEMENTARY MATERIALS

Table S1. DG offer as a function of 2D:4D and life satisfaction. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	9.27	8.07	1.91	1.30
Life satisfaction	10.08**	9.96*	9.00**	9.18**
2D:4D*Life satisfaction	-10.26**	-10.15*	-9.44**	-9.65**
Low LS	19.54***	18.22**	11.35**	10.95*
High LS	-0.98	-2.08	-7.53	-8.35
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	13.00*	11.63	1.05	0.14
Life satisfaction	8.43	8.02	6.53*	6.40
2D:4D*Life satisfaction	-8.50	-8.09	-6.87*	-6.75*
Low LS	21.50**	19.72*	7.92	6.89
High LS	4.51	3.54	-5.83	-6.61
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of OLS regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S2. UG offer as a function of 2D:4D and life satisfaction. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	1.25	1.79	-1.48	-2.33
Life satisfaction	-2.80	-2.51	0.20	0.03
2D:4D*Life satisfaction	2.88	2.59	-0.27	-0.10
Low LS	-1.63	-0.80	-1.21	-2.23
High LS	4.13	4.38	-1.75	-2.42
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	3.67	4.45	-2.76	-3.73
Life satisfaction	-5.62	-5.12	0.14	-0.32
2D:4D*Life satisfaction	5.79	5.28	0.08	0.27
Low LS	-2.12	-0.83	-2.85	-4.01
High LS	9.45*	9.74*	-2.68	-3.47
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of OLS regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S3. UG mao as a function of 2D:4D and life satisfaction. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	2.16	1.10	-3.24	-4.47
Life satisfaction	-2.37	-1.81	-4.25	-2.80
2D:4D*Life satisfaction	2.60	1.99	4.36	2.95
Low LS	-0.44	-0.89	-7.60	-7.43
High LS	4.75	3.09	1.11	-1.52
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	-1.53	-2.56	0.25	-0.11
Life satisfaction	-1.45	-0.64	1.87	2.50
2D:4D*Life satisfaction	1.63	0.78	-1.92	-2.48
Low LS	-3.16	-3.34	2.17	2.34
High LS	0.10	-1.79	-1.66	-2.59
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of OLS regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S4. TG trust as a function of 2D:4D and life satisfaction. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	1.08	0.70	2.82	1.79
Life satisfaction	5.79*	5.67*	-1.61	-2.50
2D:4D*Life satisfaction	-6.05*	-5.93*	1.80	2.70
Low LS	7.14	6.63	1.02	-0.90
High LS	-4.97	-5.24	4.62	4.50
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	-3.28	-3.61	0.59	0.31
Life satisfaction	7.94*	7.95*	-5.25	-5.04
2D:4D*Life satisfaction	-8.23*	-8.24*	5.51	5.28
Low LS	4.95	4.62	-4.92	-4.97
High LS	-11.50	-11.85	6.10	5.59
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of logistic regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S5. TG reciprocity as a function of 2D:4D and life satisfaction. Low/High LS refers to the effect of 2D:4D among individuals scoring one SD below/above the average *life satisfaction* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	8.31	9.27	-3.54	-4.04
Life satisfaction	5.72*	5.13	1.28	1.19
2D:4D*Life satisfaction	-5.75	-5.05	-1.15	-1.07
Low LS	14.07**	14.31**	-2.39	-2.97
High LS	2.56	4.24	-4.69	-5.11
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	6.23	7.26	-4.04	-0.91
Life satisfaction	5.03	4.97	1.19	4.46
2D:4D*Life satisfaction	-4.98	-4.83	-1.07	-4.40
Low LS	11.21*	12.09*	3.49	2.94
High LS	1.25	2.43	-5.31	-5.96
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of logistic regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S6. DG offer as a function of 2D:4D and self-esteem. Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	10.68*	9.35	2.38	1.56
Self-esteem	6.24	6.05	3.39	4.60
2D:4D* Self-esteem	-6.61	-6.47	-3.53	-4.75
Low SE	17.29*	15.83	5.91	6.32
High SE	4.07	2.88	-1.14	-3.19
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	14.13*	12.75*	0.82	-0.19
Self-esteem	3.91	4.11	9.28*	10.83**
2D:4D* Self-esteem	-4.20	-4.47	-9.57*	-11.15**
Low SE	18.33	17.21	10.39*	10.96*
High SE	9.93	8.28	-8.75	-11.34
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of OLS regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S7. UG offer as a function of 2D:4D and self-esteem. . Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	1.17	1.78	-1.66	-2.67
Self-esteem	-4.33	-4.67	-0.31	0.00
2D:4D* Self-esteem	4.33	4.71	0.19	-0.16
Low SE	-3.16	-2.93	-1.86	-2.51
High SE	5.51	6.49	-1.47	-2.83
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	3.13	4.07	-2.56	-3.57
Self-esteem	-5.83*	-5.96*	3.38	3.53
2D:4D* Self-esteem	5.90*	6.04*	-3.59	-3.76
Low SE	-2.79	-1.97	1.03	0.20
High SE	9.03	10.12*	-6.14	-7.33*
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of OLS regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S8. UG mao as a function of 2D:4D and self-esteem. Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	1.22	0.40	-3.45	-4.29
Self-esteem	3.74	3.77	-4.58	-5.15
2D:4D* Self-esteem	-4.06	-4.15	4.72	5.41
Low SE	5.28	4.55	-8.17	-9.70
High SE	-2.84	-3.75	1.27	1.12
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	-1.88	-2.58	0.19	-0.29
Self-esteem	0.41	1.23	3.81	2.44
2D:4D* Self-esteem	-0.60	-1.51	-3.89	-2.37
Low SE	-1.27	-1.07	4.08	2.08
High SE	-2.48	-4.09	-3.69	-2.66
Controls	no	yes	no	Yes
Observations	230	230	330	330

Estimates of OLS regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S9. TG trust as a function of 2D:4D and self-esteem. . Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	0.74	0.27	3.09	2.23
Self-esteem	9.99**	10.18**	-6.70*	-5.94
2D:4D* Self-esteem	-10.30**	-10.51**	7.05*	6.22*
Low SE	11.04*	10.78*	-3.95	-3.99
High SE	-9.56	-10.24	10.14*	8.45
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	-2.73	-3.15	0.56	0.30
Self-esteem	13.16**	13.65**	-3.99	-3.02
2D:4D* Self-esteem	-13.61**	-14.14**	4.26	3.23
Low SE	10.89*	10.99	-3.71	-2.93
High SE	-16.34**	-17.30**	4.82	3.53
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of logistic regressions . *** p<0.01, ** p<0.05, * p<0.1

Table S10. TG reciprocity as a function of 2D:4D and self-esteem. . Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

	RIGHT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	8.21	9.41*	-3.57	-4.09
Self-esteem	6.66	7.65	0.32	-0.69
2D:4D* Self-esteem	-6.75	-7.72	-0.40	0.60
Low SE	14.96**	17.14**	-3.17	-4.69
High SE	1.45	1.69	-3.97	-3.49
	LEFT HAND			
VARIABLES	MALES		FEMALES	
2D:4D	6.47	7.96	-0.32	-1.04
Self-esteem	8.11	9.76	4.23	3.50
2D:4D* Self-esteem	-8.27	-9.92	-4.40	-3.69
Low SE	14.74*	17.89**	4.08	2.65
High SE	-1.81	-1.96	-4.72	-4.74
Controls	no	yes	no	yes
Observations	230	230	330	330

Estimates of logistic regressions. *** p<0.01, ** p<0.05, * p<0.1

Figure S1. Marginal effects on DG offer. Estimates from Wald tests on the coefficients from Table S6. Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

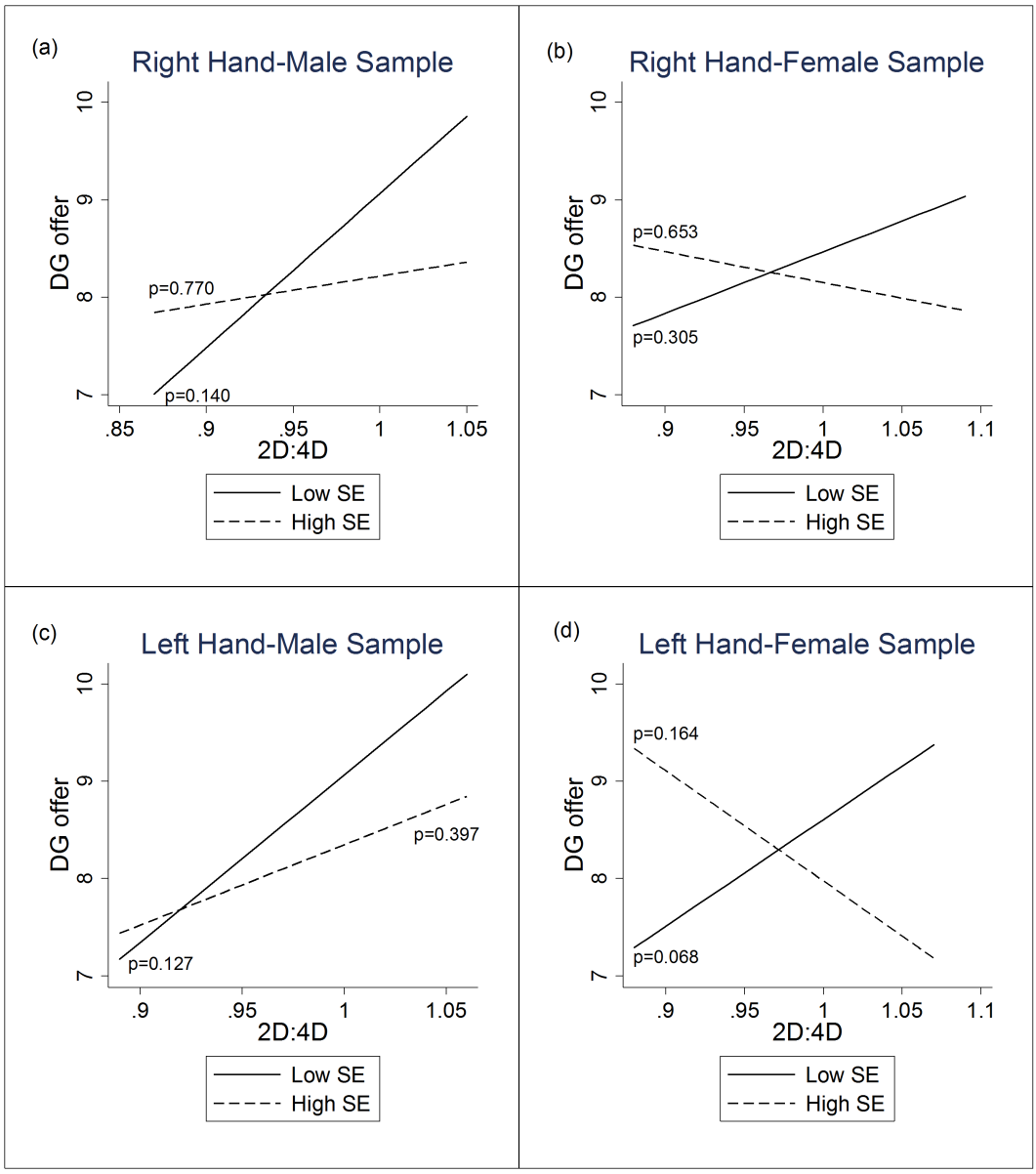

Figure S2. Marginal effects on UG offer. Estimates from Wald tests on the coefficients from Table S7. Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

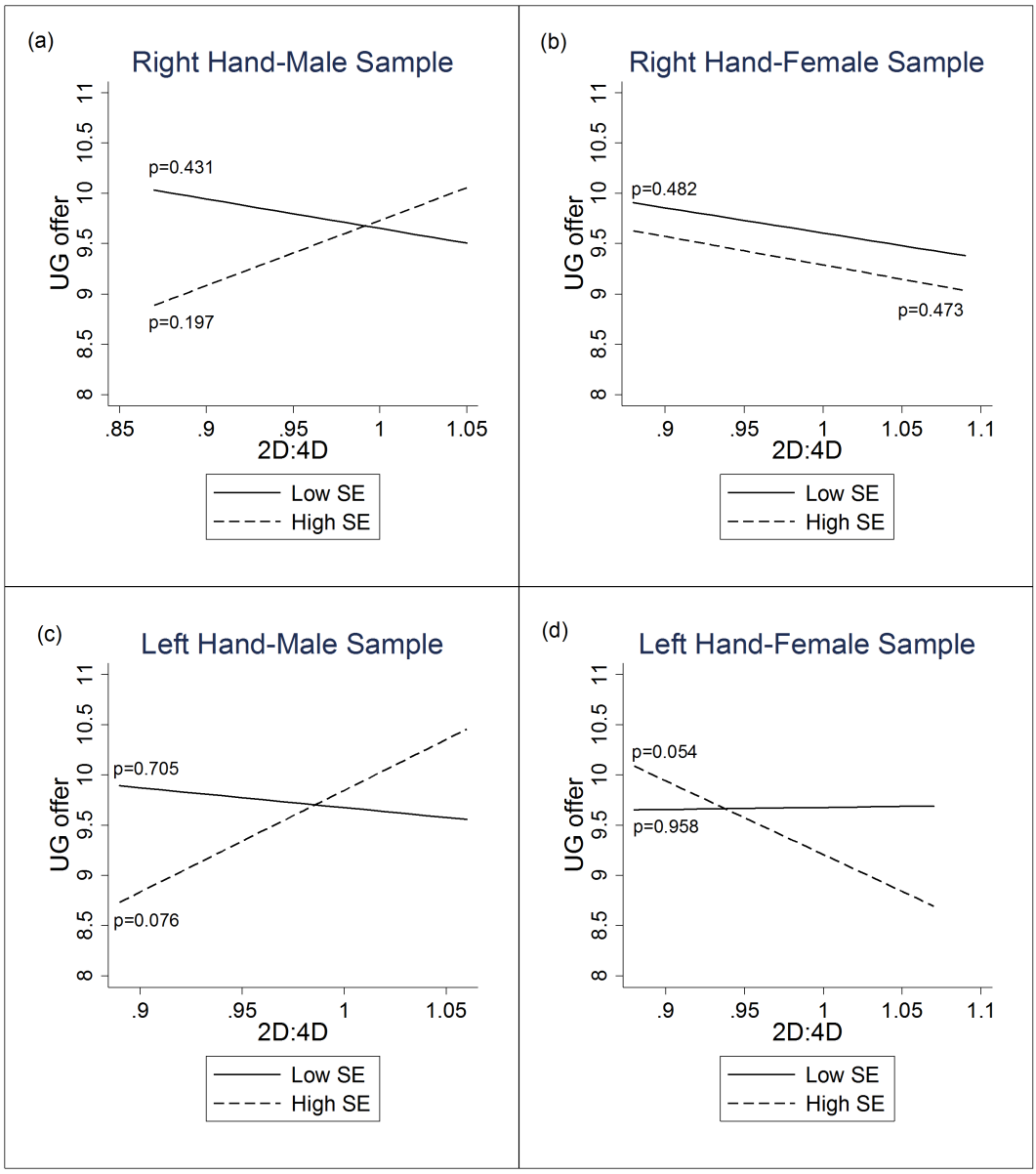

Figure S3. Marginal effects on UG MAO. Estimates from Wald tests on the coefficients from Table S8. Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

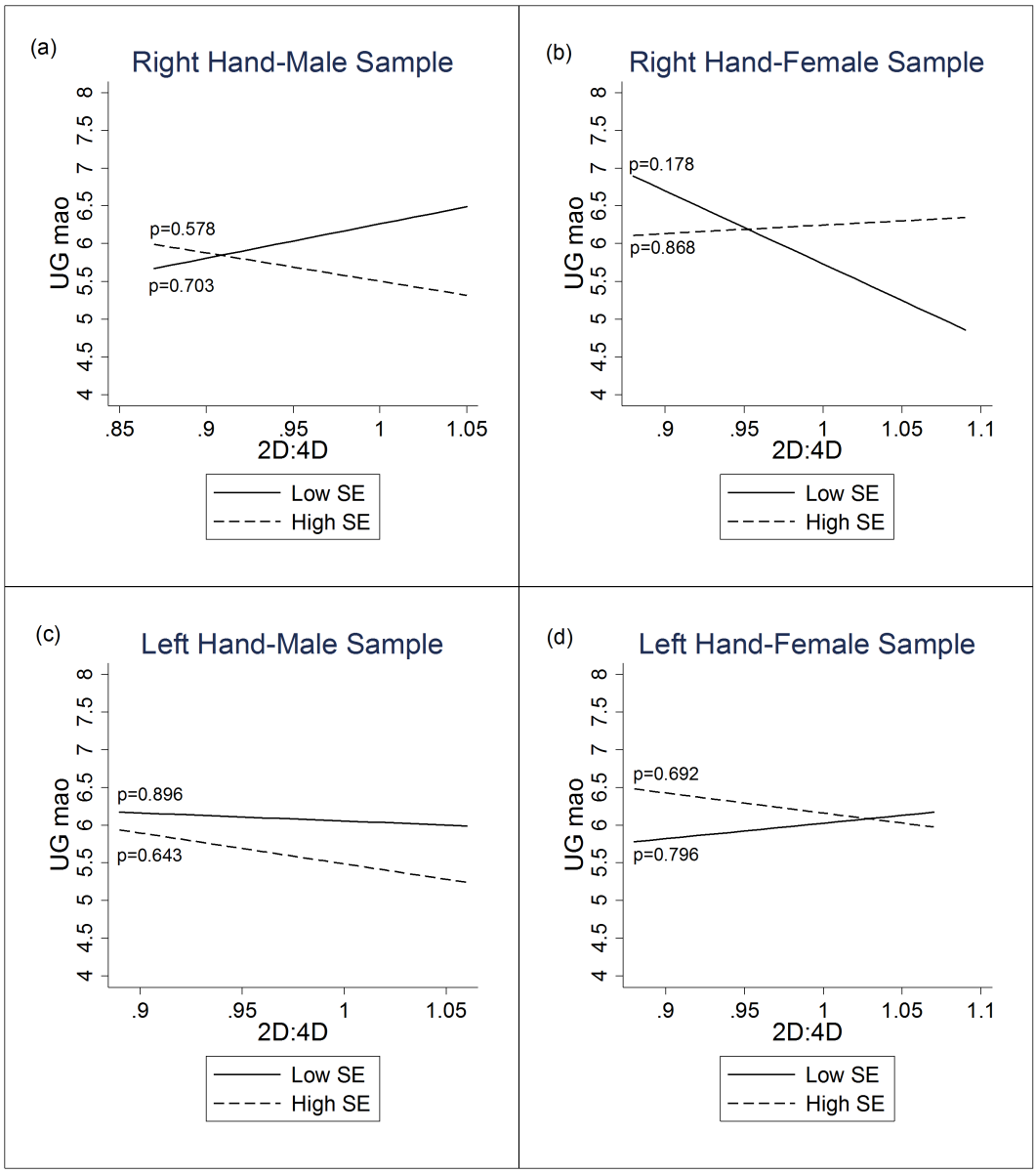

Figure S4. Marginal effects on P(TG trust=1). Estimates from Wald tests on the coefficients from Table S9. Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.

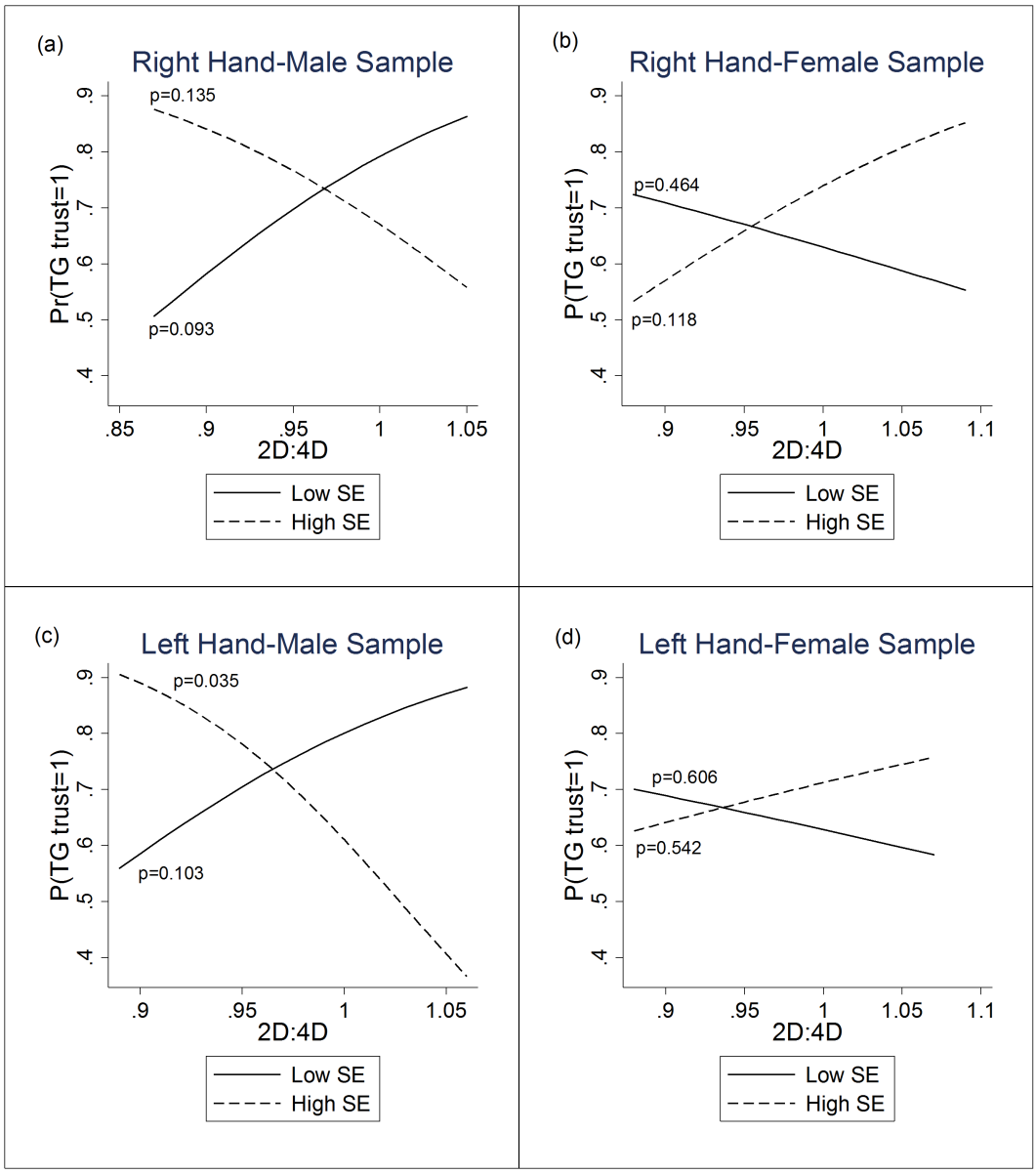

Figure S5. Marginal effects on P(TG reciprocity=1). Estimates from Wald tests on the coefficients from Table S10. Low/High SE refers to the effect of 2D:4D among individuals scoring one SD below/above the average *self-esteem* in the gender-specific sample.