

Lex Talionis: Testosterone and the Law of Retaliation

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#### Abstract

Research examining both the organizing and activating effects of testosterone in one-shot bargaining contexts has been vexed by inconsistencies. Some research finds that high testosterone men are more likely to reject unfair offers in an ultimatum game and exogenous administration of testosterone to men leads to less generous offers. In contrast, other research finds that higher prenatal exposure to testosterone predicts more generous dictator game offers and administering testosterone to women leads to more generous ultimatum game offers. The current research examines how the organizing effects of testosterone affect bargaining behavior. Because testosterone is associated with status seeking and concerns with social reputation, we hypothesized that testosterone would predict aggressive bargaining but only after provocation. Two studies found that prenatal testosterone exposure, as measured by 2D:4D ratio, led to aggressive responses for both males and females, but only after they received unfair offers. Furthermore, perceptions of fairness violations moderated but did not mediate the effect of testosterone on retributive responding. These results suggest that the organizing effects of testosterone have consistent effects on bargaining behavior for both males and females but its predictive ability requires some form of provocation to emerge.

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Perhaps the greatest adversary to homo economicus models of economic rationality is human emotion and nowhere is the lack of fit between gut reactions and optimal strategies more striking than in one-shot bargaining contexts. Take the ultimatum game; two players are given the opportunity to divide a sum of money between them. One player takes the role of the proposer and offers a portion of the sum to the responder who can either accept or reject that offer. Acceptance results in the money being divided according to the proposed proportions. Rejection of the offer condemns both parties to receive nothing. Although strict adherence to the principle of economic rationality dictates that any offer above zero should be accepted, people reliably reject offers beneath 20% (Camerer, 2003).

These spiteful rejections, although economically curious, make sense outside of true one-shot bargaining contexts. In small, stable groups with repeated interactions, accepting exploitative offers can have long-term consequences by encouraging future exploitation. As a result, especially with the possibility of repeated interaction, social exchange defaults to the principles of reciprocity (Gouldner, 1960).

The degree to which hostility is reciprocated and exploitation is rejected is likely influenced by one's level of concern with social status and challenge. Because the hormone testosterone is associated with status seeking and competition (Archer, 2006; Josephs, Sellers, Newman, & Mehta, 2006; Mazur & Booth, 1998), one might expect individual differences in testosterone to be influential in determining just how hard an individual pushes back in the face of potential exploitation. However, research examining the role of testosterone in bargaining contexts has been vexed by

inconsistencies. We first turn to the literature on circulating testosterone and then discuss studies exploring the organizing effects of testosterone on bargaining behavior.

*The Effects of Circulating Testosterone on Bargaining Behavior*

Consistent with this association between testosterone and status concerns, men and women with higher levels of circulating basal testosterone are more likely to reject unfair offers in an ultimatum game (Burnham, 2007; Mehta & Beer, 2010). Curiously however, the administration of testosterone has been shown to lead to both less generous offers for men (Zak et al., 2009) *and* more generous offers for women (Eisenegger et al. 2010).

One possible explanation for this inconsistency is that systematic differences in the level of social challenge or provocation across these studies may have been pivotal in shaping their differential effects. Indeed, the mixed results present in the literature seem to vary according the level of provocation. Burnham (2007), and Zak et al. (2009) primed a competitive frame by inviting participants to play as both proposer and responder simultaneously, and Mehta and Beer (2010) measured responses to unfair offers. In contrast, Eisenegger et al. (2010) had participants anonymously play the role of either proposer or responder with no opportunity for reciprocity.

Consistent with findings that testosterone is most predictive of behavior under conditions of social challenge and status competition, we propose that testosterone does not motivate aggressive social exchanges per se, but rather increases the appeal of *lex talionis*, or retributive justice. Our central hypothesis is that testosterone will predict bargaining behavior equally for both sexes but only after provocation (i.e., receiving unfair offers). To test this proposition, we used a measure of testosterone that captures its organizing effects and is also relatively impervious to contextual influences.

*Testosterone's Organizing Effects on Bargaining Behavior*

Testosterone not only has activating effects that emerge from both endogenous circulating levels and exogenous administration of the hormone, but it also has organizing effects on how the brain develops through prenatal exposure to this hormone (Manning, 2002). One marker of in utero androgen exposure is the ratio between the length of the index finger (2D) and the ring finger (4D), with lower ratios indicating exposure to higher levels of androgens during prenatal development (Manning, 2002). Although the correlation between 2D:4D and circulating testosterone is at best unreliable (Campbell et al., 2010; Hönekopp et al., 2007; Manning et al., 1998; Sanchez-Pages et al., 2010), research examining 2D:4D and bargaining behavior has produced results that are conceptually consistent with findings from experiments measuring circulating testosterone (Van den Bergh & Dewitte, 2006; Millet & Dewitte, 2009).

As our lex talionis theory would predict, the effect of 2D:4D on ultimatum game behavior appears to be constrained by the presence or absence of competitive cues. Consistent with comparable designs that measure circulating testosterone (Burnham, 2007; Zak et al. 2009), Van den Bergh and Dewitte (2006) implicitly primed competition by having participants simultaneously assume the roles of proposer and responder and found that males with lower digit ratios set higher thresholds for acceptance. However, in a dictator game that removed the potential for competition, lower digit ratios are associated with *more generous offers* (Millet & Dewitte, 2009). This latter finding conceptually replicates the results from the Eisenegger et al. (2010) study in which they exogenously administered testosterone and had proposers make offers anonymously with no opportunity for retaliation. In the absence of social challenge, testosterone-induced reputational concerns appear to have motivated generosity, just as testosterone seems to motivate retributive responding following a challenge.

In the current research, we chose to focus on the organizing effects of testosterone. Our primary reason for using this measure was due to its temporal stability. Circulating testosterone is subject to diurnal (Touitou & Haus, 2000), social (Booth, Granger, Mazur, & Kivlighan, 2006; Edwards, 2006) age-related, and major life event fluctuations such as marriage (McIntyre et al. 2006) and paternity (Gray, Yang, & Pope, 2006). In addition, Eisenegger et al. (2010b) suggested that pre-experiment acts of aggression can inflate circulating testosterone levels and thus the relative stability of 2D:4D also circumvents concerns over reverse causality.

We conducted two experiments to examine the relationship between social challenge and the organizing effects of prenatal testosterone exposure, as measured by 2D:4D. Our main hypothesis is that the organizing effects of testosterone do not motivate aggressive social exchanges per se, but rather increase the appeal of *lex talionis*, or retributive justice. That is, we propose that testosterone will predict aggressive bargaining for both males and females but only after provocation (i.e., receiving unfair offers). By having the game played face-to-face, and having players switch roles for a surprise second round, we were able to use return offers as a measure of retaliation.

#### Experiment 1: Testosterone and Retributive Justice

*Participants.* Forty-eight first year psychology students (28 male) with a mean age of 19 ( $SD=1.91$ ) participated in exchange for course credit.

*Ultimatum Game.* Participants arrived at the lab and took part in what was ostensibly a one-shot negotiation. The ultimatum game was played face-to-face for real cash stakes of \$40 and participants were informed in the event of an agreement being reached they would keep the money at the conclusion of the experiment. The cash was placed on the table in \$5 notes between the two parties. The rules of the game were

explained and all participants were told that there would be only one round of the game and that they would be playing the part of the responder. All participants then received a very low offer of \$5 from a same-sex confederate.

Participants were then told that there would in fact be one more round of the ultimatum game with the roles reversed and participants proposing a division of a different \$40. By reversing the roles, we gave participants the opportunity to retaliate for the low offer they received in the first round.

*Digit Ratio.* To control for any confounding effects arising from priming folk theories regarding testosterone (Eisenegger et al., 2010), testosterone was not mentioned at any point during data collection. Images of participants' right hands were acquired via a flatbed scanner at the conclusion of the experiment and second and fourth digits subsequently measured from the ventral proximal crease of the digit to the tip of the finger. Where there was a band of creases at the base of the digit we measured from the most proximal crease (Millet & Dewitte, 2007).

Digit ratio was calculated by dividing the length of the 4<sup>th</sup> digit on the right hand by the length of the 2<sup>nd</sup> digit on the right hand (Manning, 2002; Ronay & von Hippel, in press). The digit ratio of males ( $M=.95$ ,  $SD=.03$ ) did not differ from females ( $M=.97$ ,  $SD=.03$ ),  $t(46)=1.47$ ,  $p=.15$ ,  $d=.43$ .

### *Results*

*Rejection Rate.* As expected, the face-to-face context resulted in a high rejection rate across the sample<sup>1</sup>, 71%,  $SE=13\%$ . There was no relationship between digit ratio and the dichotomous variable of offer acceptance  $Wald=.09$ ,  $p=.76$ .

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<sup>1</sup> Rejection rates tend to be lower when participants are economics students with exposure to game theory (e.g. Burnham, 2007).

*Return Offers.* Return offers ranged from 5 to 20,  $M=14.48$ ,  $SD=5.86$ . Consistent with predictions, regressing return offers on digit ratio and gender revealed a main effect for 2D:4D such that participants whose digit ratios reflected higher levels of prenatal testosterone exposure made lower return offers  $\beta=.44$   $t(45)=3.20$ ,  $p<.01$ . There was no main effect for gender,  $\beta=.06$   $t(45)=.39$ ,  $p=.70$ , nor was the interaction between gender and 2D:4D significant,  $\beta=-.02$ ,  $t(44)=-.16$ ,  $p=.87$ . Even analyzed separately, testosterone predicted lower return offers for both men ( $\beta=.43$ ,  $p=.02$ ) and women ( $\beta=.43$ ,  $p=.056$ ). Participants higher in prenatal exposure to testosterone retaliated for the low offers they received earlier by now offering low offers themselves and this was true for both males and females.

#### *Experiment 2: Is Social Challenge a Necessary Condition?*

Although consistent with our predictions, one limitation of Experiment 1 is that we did not manipulate whether the initial offers were fair or not, leaving it unclear if this is a necessary element in the testosterone-retaliation link. It could be that individuals with low digit ratios are *always* more aggressive, rather than simply being more prone to retributive responding as we have proposed. Experiment 2 manipulated the fairness of the initial offers to test whether the effect of Experiment 1 would emerge only following provocation.

Experiment 1 also provided no indication of the psychological mechanisms underlying the relationship between 2D:4D and aggressive retaliation. As perceived fairness has been invoked as a universal explanation for the rejection of low offers in ultimatum games (Henrich et al., 2010), one possibility is that higher levels of prenatal testosterone exposure increase perceptions that fairness has been violated. If this is the case, then perceived fairness should mediate the relationship between testosterone and return offers.

An alternative possibility is that individual differences in testosterone have no direct bearing on how fair one perceives an offer to be; rather testosterone's effects may lie in moderating behavioral responses to fairness violations. That is, a moderating effect of perceived fairness would suggest that all participants perceive low offers to be unfair, but only those with higher levels of testosterone are willing to act on their sense of unfairness by responding with retribution (i.e. offering low offers themselves). Experiment 2 therefore measured participants' perceptions of fairness to see whether either might mediate or moderate the relationship between testosterone and aggressive responding.

*Participants.* Having found no sex effect in Experiment 1 we switched to a male-only sample for Experiment 2. Forty-one male first year psychology students with a mean age of 19 years ( $SD=2.12$ ) participated in exchange for course credit. Participants were randomly allocated to a fair ( $n=20$ ) or unfair ( $n=21$ ) condition and paired with a male confederate, who was ostensibly another participant in the experiment.

*Fairness Manipulation.* As in Experiment 1, the ultimatum game was played for real cash stakes of \$40 and participants were informed that in the event of an agreement being reached they would keep the money at the conclusion of the experiment. All participants were first allocated the role of responder in the ultimatum game. In the *fair condition* the confederate offered \$20. In the *unfair condition* the confederate offered \$5. After deciding whether they would accept the offer, participants privately responded to the question, "How fair do you feel the offer you received was?" on a 5-point scale (1 being extremely unfair and 5 being extremely fair).

In a surprise second round, the game roles were reversed; the participant divided an additional sum of \$40 and offered a portion to the confederate.

*Results and Discussion*



*Rejection Rate.* Consistent with previous studies (Mehta & Beer, 2010)

participants were more likely to reject unfair offers ( $M=67\%$ ,  $SE=10\%$ ) than fair offers, ( $M=5\%$ ,  $SE=5\%$ ),  $F(1,39)=27.05$ ,  $p<.01$ . As in Experiment 1, this effect of condition on acceptance was unaffected by digit ratio ( $M=.95$ ,  $SD=.02$ ),  $Wald=.73$ ,  $p=.39$ .

*Return Offers.* Return offers ranged from 10 to 20,  $M=19.25$ ,  $SD=2.45$  in the fair condition, and from 5 to 20,  $M=13.81$ ,  $SD=5.46$  in the unfair condition. Consistent with results from Experiment 1, digit ratio was a significant predictor of return offers  $\beta=.38$ ,  $t(37)=3.48$ ,  $p<.01$ . However, there was also a significant interaction between digit ratio and condition  $\beta=.30$ ,  $t(37)=2.72$ ,  $p=.01$ . In the unfair condition, digit ratio predicted the size of return offers; participants whose digit ratios reflected higher prenatal testosterone exposure made lower return offers  $\beta=.52$ ,  $t(19)=.66$ ,  $p<.01$ . In contrast, digit ratio did not predict responses in the fair condition  $\beta=.18$ ,  $t(18)=.17$ ,  $p=.49$  (see Figure 1).

*Prenatal testosterone exposure affects responses to, but not perceptions of fairness.*

Regressing perceived fairness onto condition and 2D:4D revealed a significant main effect for condition (for the fair condition  $M=4.80$  ( $SD=.41$ ) and for the unfair condition  $M=1.62$  ( $SD=.74$ )),  $\beta=-.94$ ,  $t(37)=-16.86$ ,  $p<.01$ . However, digit ratio was unrelated to perceived fairness,  $\beta=-.01$ ,  $t(37)=-.01$ ,  $p=.99$ , as was the interaction between condition and digit ratio  $\beta=.08$ ,  $t(37)=1.42$ ,  $p=.16$ , thus violating the necessary conditions for mediation (Muller, Judd, Yzerbyt, 2005).

We next tested whether digit ratio moderated the relationship between perceived fairness and return offers. Regressing return offers onto digit ratio and perceived fairness revealed main effects for both digit ratio,  $\beta=.41$   $t(37)=3.54$ ,  $p<.01$ , and perceived fairness,  $\beta=.59$ ,  $t(37)=5.06$ ,  $p<.01$ . An interaction between digit ratio and perceived fairness also emerged,  $\beta=-.24$ ,  $t(37)=-2.15$ ,  $p<.05$ . Among low-digit-ratio

participants, perceived fairness strongly predicted return offers  $\beta=.81$ ,  $t(37)=5.37$ ,  $p<.01$ , whereas among high-digit-ratio participants the effect was significantly smaller,  $\beta=.33$ ,  $t(37)=1.99$ ,  $p=.05$  (see Figure 2). Overall, testosterone did not alter the perceived fairness of low-ball offers but affected whether participants felt justified in acting on their sense of unfairness by responding with low offers themselves.

### General Discussion

The current research tested whether the organizing effects of prenatal testosterone exposure predict aggressive responses only after provocation. Across two experiments individual differences in prenatal exposure to testosterone predicted retributive responding after receiving unfair offers. In Experiment 1, both male and female participants whose digit ratios indicated higher levels of prenatal testosterone exposure made lower return offers following an unfair offer. Experiment 2 replicated the effect in an unfair offer condition, but found that when participants received a fair offer of 50%, digit ratio no longer predicted return offers. Experiment 2 also found digit ratio did not alter the *perceived* fairness of low-ball offers but predicted how people *responded* to this unfairness. Those with lower digit ratios were more likely to act on their sense of unfairness by responding with retribution. Our findings suggest that the organizing effects of prenatal testosterone exposure lead individuals to embrace confrontation as a means of communicating unwillingness to be exploited by others.

It is curious that across both experiments that testosterone's effects were associated with low return offers but, similar to Eisenegger et al. (2010) and Zak et al. (2009), had no bearing on rejection rates, as both provide a means of punishing others for their offense. One possible explanation for this is that in contrast to some previous designs, our experiment provided no measure of minimum acceptance level; rather, we only assessed willingness to accept a rather low offer. Consequently, our rejection rate

variable provided little variance, and was notably higher than in previous research (Mehta & Beer, 2010; Burnham, 2007). These high rejection rates, possibly exacerbated by the face-to-face design and the large sums of money, may have obscured a possible relationship with testosterone. Future research should vary how unfair the offer is to see if testosterone emerges as a predictor of offer acceptance when there is more variability.

### Conclusion

Violations of fairness present individuals with a difficult choice. Should one turn the other cheek in an attempt to placate the aggressor, offering submission and forgiveness as a conciliatory path to peace? Or alternatively, should one respond in kind, risking escalation and further aggression in order to cultivate a reputation of pluck and principle? While having its place, such a tit-for-tat strategy is best employed judiciously, lest one's nose be cut off in an attempt to save face. The present data suggest that testosterone is influential in shaping such responses. The fact that testosterone both motivates a preference for retributive justice and undermines the neural basis of self-control (Mehta & Beer, 2010) may be one reason why many advise that revenge, is indeed a dish best served cold.

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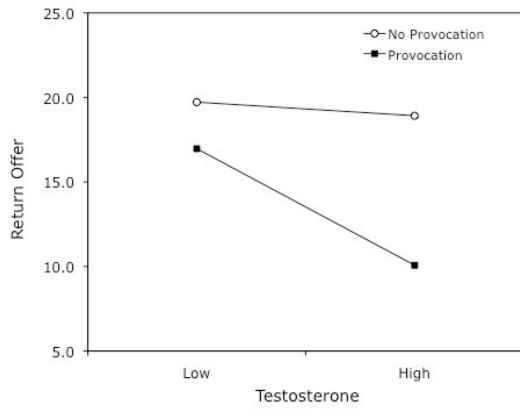


Figure 1

Mean return offer in ultimatum game by provocation and 1 SD  $\pm$  Mean on testosterone.

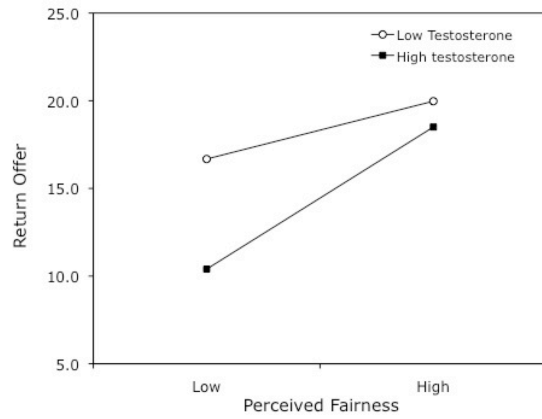


Figure 2

Mean return offer in ultimatum game by perceived fairness and 1 SD  $\pm$  Mean on testosterone.