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RESEARCH REPORT

SECOND TO FOURTH DIGIT RATIO AND COOPERATIVE BEHAVIOR

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Second to fourth digit ratio and cooperative behavior.

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Second to fourth digit ratio and cooperative behavior.

Abstract

A low second to fourth digit ratio (2D:4D) has been related to high testosterone levels and to markers of high status. In a social dilemma context status can be obtained either by acting egoistically (i.e. not contributing one's share) or by acting altruistically (i.e. contributing more than one's fair share). We therefore predicted that a low 2D:4D would be associated with high levels of egoism *and* altruism and low levels of common cooperativeness (i.e. contributing exactly one's fair share). We found the exact opposite: participants with a low 2D:4D were more likely to act cooperatively and less likely to act altruistically and egoistically. These findings suggest that (1) there might be a high and a low testosterone strategy to gain status and (2) that the high testosterone strategy is characterized by a preference for normative behavior.

Second to fourth digit ratio and cooperative behavior.

A low second to fourth digit ratio (2D:4D) has been related to high prenatal testosterone levels (Manning et al., 1998; Manning, 2002) and to a number of psychological factors such as masculine gender identity (Csatho et al., 2003), aggression in men (Bailey & Hurd, in press), high status in competitive sports (Manning & Taylor, 2001) and in music (Sluming & Manning, 2000). In younger humans, a low 2D:4D has been related to lower levels of prosocial behavior in pre-school girls (but not in boys) (Williams, Greenhalgh, & Manning, 2003), and to physical (but not verbal) aggression in school boys (Manning & Wood, in Manning, 2002). High testosterone has been related to high dominance status (Mazur & Booth, 1998) and the correlates of a low 2D:4D seem consistent with this interpretation.

Hitherto, a low 2D:4D has been related to outcomes that mark status (e.g. status in music, fertility; Manning, 2002), or to traits that are believed to either lead to, maintain, or reflect high status (e.g. gender identity, and aggression). In this paper, we explore whether the relationship between 2D:4D and status exists at the behavioral level. Testosterone seems to have an impact on social behavior (Mazur & Booth, 1998). A well-documented type of social behavior is cooperative behavior in social dilemmas. Social dilemmas are characterized by a conflict between collective and individual interests (Hardin, 1968).

The findings reported in the literature do not allow straightforward predictions with respect to cooperativeness in low 2D:4D people. There are two possibilities. Low levels of cooperation in social dilemmas are typical of a strategy that strives towards maximizing the *differences* between one's own benefits and those of others (van Lange, 1999). Two other often used interactive strategies, specifically 'maximizing

one's own gains', and 'minimizing the difference between one's own benefits and those of others', often yield higher levels of cooperation in social dilemmas. Because one individual's status gain entails an other individual's status loss by definition, a strategy that maximizes differences between one's own and others' benefits (i.e. low cooperation levels) seems consistent with status gain, and hence, with higher levels of testosterone.

Hypothesis 1 therefore proposes that a lower 2D:4D, as a marker of higher prenatal testosterone level and a precursor of high status, should be related to lower contribution levels in social dilemmas. This comes down to a positive correlation between 2D:4D and contribution level. A low 2D:4D ratio has indeed been shown to be related to lower levels of (aggregate) prosocial behavior and lower social cognition (Williams et al., 2003), at least in girls.

There is a second possibility. Other literature suggests that the relation between 2D:4D and contribution in social dilemmas might not be linear but rather curvilinear. To explain the reasoning, it is useful to distinguish altruistic behavior from 'common' cooperativeness. In many social dilemmas people have a clear idea about what constitutes appropriate behavior and free-riding. Paying for one's ticket for the opera is appropriate, whereas trying to get in for free is not appropriate (i.e. is free-riding). In many real life circumstances, however, a third option exists: One can contribute more than the appropriate contribution level. To help the orchestra survive one could pay for a program booklet or contribute more than the ticket price. At first sight, this type of behavior seems irrational. However, the cost incurred by such a type of behavior has been identified as a costly signal of some underlying quality (e.g. Glazer & Konrad, 1996; Roberts, 1998; Zahavi & Zahavi, 1997). Consistent with the costly signaling perspective on altruism, altruistic behavior has been shown to be

competitive on some occasions (Barclay, 2004), and has been shown to increase status, both in field settings (Bliege-bird, Smith, & Bird, 2001) and in lab situations (Dewitte & De Cremer, 2004).

Because a low 2D:4D seems to be related to high status (see above), and altruism (i.e. doing more than what is "appropriate") appears in the recent literature as one means to reach high status (e.g. Bliege-Bird et al., 2001), altruism might be related to a low 2D:4D. Considering that acquiring resources (e.g. hunting large game) involves a lot of risky behavior (e.g. Bliege-Bird et al. 2001), a link between testosterone and altruism is at least conceivable. This leads to hypothesis 2: a low 2D:4D might be related to higher levels of egoism *and* higher levels of altruism in social dilemmas, and to lower levels of 'appropriate' levels of cooperative behavior. Therefore, according to hypothesis 2 we expect a quadratic relationship between 2D:4D and contribution level.

Typical social dilemma games often obscure altruistic acts because only two options (i.e. cooperate or not) are available to the players or because it does not make much sense to give more than what is appropriate. In this paper, we adapted the traditional public good game slightly to allow differentiation between cooperation and altruism. In this way we could tease both hypotheses apart.

Participants. Seventy undergraduate students (43 women and 27 men) at the University of Leuven, aged between 18 and 23, participated in this study. The monetary reward depended on their performance (with a minimum of 5 euro, €1 ≈ $1).

Method. We used a social dilemma situation, namely a repeated public good game with four players. At the beginning of each round of the game, all participants received an endowment of 40 points. In each round, they had to decide how much of

the endowment they would invest in the public good or keep for themselves. Decisions were made simultaneously. Every point was worth 3.39 eurocent. All the points that were invested, were subtracted from their 40 points endowment. When the sum of all contributions reached the provision point (= 100 points), 160 points (= the public good) were distributed equally across the four players, irrespective of their individual contributions. The norm equals the provision point divided by the number of players. In a pre-test (N = 32), we asked what the appropriate behavior would be in this type of situation. Ninety-seven percent of the people answered that people should invest 25 points, which suggests that this is indeed the appropriate behavior in this situation.

Upon arrival in the laboratory, each participant was assigned to a computer in a partially enclosed carrel. Participants did not see one another and could not talk. They believed that they played a game involving six people, but in reality they played against the PC. We told that four of the six participants were players in the game, and that two others were observers of the game. The observers did not play themselves But they were told that the roles of player and observer could change randomly during the game.

All participants started as an observer and they observed twice that the good was not obtained. In the first round, the shortage was 5 (out of 100) points. In the second round, the shortage was 2 points (out of 100). They did not receive information about individual contribution levels. After the first two rounds, the participants replaced one person in the game and had to decide how much to invest in the public good. We distinguished three behavioral categories, defined in relation to the fair share, i.e. the provision point divided by the number of players (= 25). They could contribute either exactly the fair share (= cooperative decision), less than the

fair share (= egoistic decision), or more than the fair share (= altruistic decision). We registered participants' decisions (cooperative, egoistic or altruistic) in the first round they played (i.e. the third round of the game). The first hypothesis implies that 2D:4D will be lower among egoistic decision makers than among cooperative and altruistic decision makers. The reasoning underlying hypothesis 1, however, does not allow to predict a difference between cooperative and altruistic decision makers. In contrast, the second hypothesis implies that 2D:4D will be higher among the cooperative decision makers and lower among both egoistic and altruistic decision makers (i.e. the two strategies that are related to high status). To make both hypotheses clear, we present them in a graph (see Figure 1).

insert Figure 1 about here

After the game, the right-hand was scanned to measure finger lengths. Participants placed their hand palms on the glass plate of a scanner. We ensured that details of major creases could be seen on the scans. Lengths of the second and fourth digits were measured from the ventral proximal crease of the digit to the finger tip by means of an Adobe® Photoshop 7.0 tool. We measured from the most proximal crease when there was a band of creases at the base of the digit. Using scanned pictures is a valid method to measure finger lengths (Williams et al., 2003).

Reliability of measurement. The lengths of index (2D) and ring (4D) fingers were measured twice by the same rater with a time span of ten weeks. The two measurements of 2D:4D were highly correlated ($r = .96$, $p < .0001$, $N = 70$). In the analysis, we used the average between the two measurements. An independent rater also measured finger lengths. His computed 2D:4Ds were highly correlated with the compound measure ($r = .95$). Raters were blind to contribution level and gender.

Results. In accordance with previous literature (e.g. Fink et al., 2004; Lippa, 2003; Manning, 2002; Williams et al., 2003), 2D:4D was significantly lower for men (M = .956, SD = .025) than for women (M = .975, SD = .027; $t(68) = -3.01$, $p < .005$).

Thirty participants acted cooperatively, 19 altruistically and 21 egoistically. In contrast with hypothesis 1, the correlation between contribution size and 2D:4D was not positive, $r = -.06$ (*ns*., for men and women resp. -.01, *ns*. and -.03, *ns*.). We performed a 2 (Sex) by 3 (Public Goods Choice) factorial Anova to examine hypothesis 2. We found a significant main effect of Sex (F (1, 64) = 7.95, $p < .01$) and a marginally significant main effect of Public Goods Choice ($M_{egoistic}$ = 0.972, $SD_{egoistic}$ = .026; $M_{cooperative}$ = 0.959, $SD_{cooperative}$ = .024; $M_{altruistic}$ = 0.977, $SD_{altruistic}$ = .031; F (2, 64) = 2.99, $p < .06$). As expected, the quadratic trend was significant (F (1, 64) = 5.82, $p < .04$). However, Figure 2 shows that the trend went in the opposite direction as expected in hypothesis 2. Players that contributed the fair share, had a *lower* 2D:4D than either the players that contributed more than the fair share or the players that contributed less than the fair share. The interaction between Sex and Public Goods Choice did not approach significance (F (2, 64) = .70, p = .50). Figure 2 shows that the trend is parallel for men and women.

insert Figure 2 about here

Discussion. In the public good game we designed, we found a curvilinear relation between the 2D:4D ratio (reflecting prenatal testosterone level) and level of contribution. Specifically, egoists and altruists (as identified through their choice) had a relatively higher 2D:4D, whereas common cooperators had a relatively lower 2D:4D. How could our findings that a low 2D:4D is related to norm-consistent cooperative behavior in a public good game be reconciled with traits such as aggression and masculinity that have been related to a low 2D:4D? We consider that

acting cooperatively in the public good game reflects a strong preference for social norms (= giving the fair share). Possibly, the status indicators that are related to a low 2D:4D require a strong preference for normative behavior. For instance, becoming a top soccer player implies high skill but also requires the player to follow the rules of the game and the coach's instructions. Czikszentmihalyi (1997) interviewed hundreds of very successful people in domains as various as top sports, science, business, and arts. The most salient characteristic common to all these people was that their creativity relied on a profound knowledge of their field. Compliance with the ruling standards seems to be a necessary condition to reach the top, whatever the domain one is in. Aggression and masculinity might be related to cooperation if one considers that those following the cooperative norm are willing to punish those who free-ride (Fehr & Gächter, 2002). Consistently, Axelrod (1984) found that the most successful interactive strategies in social dilemma's was nice but tough (i.e. retaliatory).

Given that altruism is related to status (Bliege-bird, Smith, & Bird, 2001) as well as to high 2D:4D, the relation between 2D:4D (and testosterone) and status might be less linear than previously assumed. Possibly, two major strategies to obtain status could exist next to each other (Henrich & Gil-white, 2001): (1) the well-known testosterone driven, norm-abiding, aggressive, 'masculine' strategy yielding dominance status, and (2) a non-normative, generous, 'feminine' strategy yielding prestige status. The former seems related to low 2D:4D, and the latter might be related to high 2D:4D. We call for future research that explores the possible fitness advantages of a high 2D:4D, and the environmental moderators that determine which strategy is the best. We also do not know at this point whether current testosterone levels or rather an early formed personality trait mediates the relation between

prenatal testosterone and cooperative behavior. Insight into this process might also help explain the relation between norm-following cooperation and testosterone.

References

Axelrod, R. (1984). *The evolution of cooperation*. New York: Basic Books.

Bailey, A.A., & Hurd, L. (In Press). Finger length ratio (2D:4D) correlates with physical aggression in men but not in women. *Biological Psychology*.

Barclay, P. (2004). Trustworthiness and competitive altruism can also solve the "Tragedy of the Commons". *Evolution and Human Behavior, 25,* 209-220.

Bliege-Bird, R., Smith, E.A., & Bird, D.W. (2001). The hunting handicap: costly signaling in human foraging strategies. *Behavioral Ecology and Sociobiology*, 50, 9-19.

Csatho, A., Osvath, A., Bicsack, E., Karadi, K., Manning, J., & Kallai, J. (2003). Sex role identity related to the ratio of second to fourth digit length in women. *Biological Psychology, 62*, 147-156.

Csikszentmihalyi, M. (1996). Creativity: Flow and the psychology of discovery and invention. New York: Harper Collins.

Dewitte, S., & De Cremer, D. (2004). Give and you shall receive. Give more and you shall be honored. Experimental evidence for altruism as costly signaling. *Working paper, Dept. of Applied Economics 0458*, University of Leuven, Belgium.

Fehr, E. & Gächter, S. (2002). Altruistic punishment in humans. *Nature, 415*, 137-140.

Fink, B., Manning, J.T., Neave, N, & Tan, U. (2004). Second to fourth digit ratio and hand skill in Australian children. *Biological Psychology, 67*, 375-384.

Glazer, A., & Konrad, K. A. (1996). A signaling explanation for charity. *American Economic Review, 86*, 1019-1028.

Henrich, J., & Gil-White, F.J. (2001). The evolution of prestige. Freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behavior, 22*, 165-196.

Lippa, R.A. (2003). Are 2D:4D finger-length ratios related to sexual orientation? Yes for men, No for women. *Journal of Personality and Social Psychology, 85*, 179-188.

Manning, J.T. (2002). *Digit ratio: a pointer to fertility, behaviour, and health*. New Brunswick, New Jersey: Rutgers University Press.

Manning, J.T., Scott, D., Wilson, J., & Lewis-Jones, D.I. (1998). The ratio of 2nd to 4th digit length: a predictor of sperm numbers and concentration of testosterone, leutinizing hormone and oestrogen. *Human Reproduction, 1311*, 3000-3004.

Manning, J.T., & Taylor, R.P. (2001). Second to fourth digit ratio and male ability in sport: implications for sexual selection in humans. *Evolution and Human Behavior, 22*, 61-69.

Mazur, A., & Booth, A. (1998). Testosterone and dominance in men. *Behavioral and brain sciences, 21*, 353-397.

Roberts, G. (1998). Competitive altruism: From reciprocity to the handicap principle. *Proceedings of the Royal Society Series B: Biological Sciences, 265*, 427-431.

Sluming, V.A., & Manning, J.T. (2000). Second to fourth digit ratio in elite musicians: Evidence for musical ability as an honest signal of male fitness. *Evolution and Human Behavior, 21*, 1-9.

Van Lange, P.A.M. (1999). The pursuit of joint outcomes and equality in outcomes: an integrative model of social value orientation. *Journal of Personality and Social Psychology, 77*, 337-349.

Williams, J.H.G., Greenhalgh, K.D., & Manning, J.T. (2003). Second to fourth finger ratio and possible precursors of developmental psychopathology in preschool children. *Early Human Development, 72*, 57-65.

Figure 1. 2D:4D as hypothesized functions of public goods choice

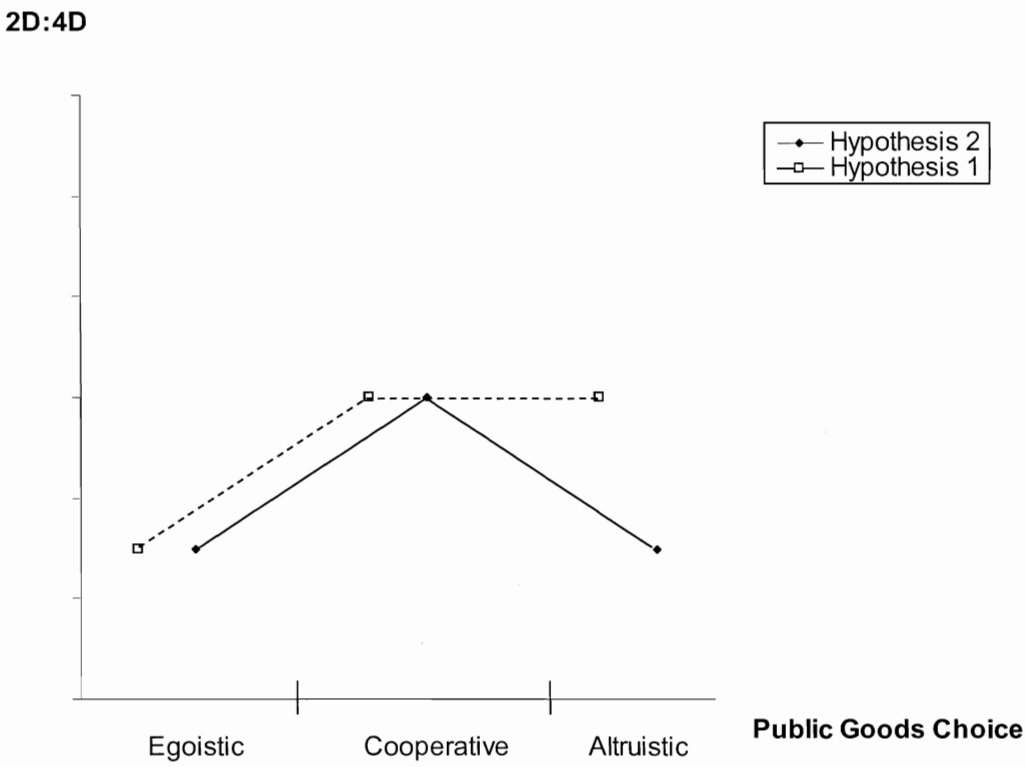

Figure 2. 2D:4D as a function of public goods choice