



Finger length ratio (2D:4D) and sex differences in aggression during a simulated war game

Matthew H. McIntyre^{a,*}, Emily S. Barrett^b, Rose McDermott^c,
Dominic D.P. Johnson^d, Jonathan Cowden^c, Stephen P. Rosen^e

^a Department of Epidemiology, Harvard University, 677 Huntington Avenue, Boston, MA 02115, United States

^b Department of Anthropology, Harvard University, 11 Divinity Avenue, Cambridge, MA 02138, United States

^c Department of Political Science 9420, University of California, Santa Barbara, CA 93106-9420, United States

^d Society of Fellows and Woodrow Wilson School of Public and International Affairs, Princeton University,
Robertson Hall, Princeton, NJ 08544-1013, United States

^e Department of Government, Harvard University, 1875 Cambridge Street, Cambridge, MA 02138, United States

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Abstract

We tested the association between a biomarker of early sex differentiation, the second-to-fourth finger length ratio (2D:4D), and unprovoked attack during a simulated war game ($n = 176$). We also investigated whether 2D:4D mediated the tendency for men to attack more than women and whether personality dimensions previously associated with sex differences in aggression or hostility (social dominance orientation, narcissism, perceived stress, and self-esteem) mediated either relationship. We found that sex and lower, more male-typical, 2D:4D predicted unprovoked attack independently. In men, high levels of narcissism predicted greater than 10 times greater odds of attacking. We also found non-monotonic effects of social dominance orientation and of perceived stress on unprovoked attack, which were not as predicted. However, we saw no evidence that effects of sex or 2D:4D were mediated by the personality dimensions we measured. © 2006 Elsevier Ltd. All rights reserved.

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* Corresponding author. Tel.: +617 549 1627.

E-mail address: mmcintyr@hsph.harvard.edu (M.H. McIntyre).

1. Introduction

The association between aggression in humans and underlying psychological, physiological, and evolutionary determinants is complicated by the diversity of ways in which aggression can occur or be defined, including direct interpersonal aggression, political aggression or warfare, and political opinions about war. In this paper, we consider the role of sex differences in political aggression or warfare.

Research into sex differences in political aggression in humans have primarily employed one of a few designs: studies showing that high levels of female political power influences countries' histories of interstate conflict (Caprioli, 2003; Melander, 2005), or internal conflict (Caprioli, 2005), or experimental studies employing simulated war games in which participants pretend to lead countries (McDermott & Cowden, 2001). In a simulated war game experiment, men both spent more of their simulated countries' revenues on the military and attacked counterparts more often than women (McDermott & Cowden, 2001).

The relationship of sex differences in political aggression with sex differences in interpersonal aggression is unclear. Interpersonal aggression can take forms varying from direct physical attacks to verbal attacks to more indirect, "relational" forms, like gossip, with the prior being used more often by men (Buss & Perry, 1992) and the latter by women (Archer & Coyne, 2005; Campbell, Sapochnik, & Muncer, 1997). Moreover, aggression can be understood in more instrumental terms, implying a will to control others, or in more expressive terms, implying a loss of emotional control on the part of the actor, with more men employing the former interpretation and women the latter (Archer & Latham, 2004).

Sex differences in aggression arise prior to puberty. As early as 1 year of age, boys prefer to throw or hit when angry and girls to cry, and by 8 years old girls begin to employ relational forms of aggression (Potegal & Archer, 2004). Forms of aggression preferred by boys include both direct attacks and preference for war games involving only play attacks, and are not strongly dependent on parental attitudes toward aggression or gender norms (Hellendoorn & Harinck, 1997; MacCoby, 1998). Sex differences in aggression are amplified during puberty, later followed by reduction in direct physical aggression as a means of striving for social dominance, which remains strongly sex different (Pratto, Sidanius, Stallworth, & Malle, 1994; Sidanius, Levin, Liu, & Pratto, 2000).

Greater male interest in social dominance might explain some of the sex differences observed in political opinions (Pratto et al., 1994; Pratto, Stallworth, & Sidanius, 1997), which include opinions about war (Heskin & Power, 1994). To the extent that sex differences are driven by differences in instrumental motives, social dominance orientation (SDO) might play an important role (Ramirez & Andreu, 2006). However, recent research has suggested that social dominance orientation (SDO) is only useful in explaining opinions about war in which specific justifications for instrumental motives, such as racism, other forms of prejudice, or devaluation of enemy life play an important role (Altmeyer, 2004; Crowson, DeBacker, & Thoma, 2005; Henry, Sidanius, Levin, & Pratto, 2005; McFarland, 2005).

Other personality dimensions, like narcissism, are also associated with interpersonal aggression (Pope, Kouri, & Hudson, 2000; Stucke & Sporer, 2002; Twenge & Campbell, 2003), and perhaps by extension with attitudes toward war or political aggression. The association between narcissism and aggression may overlap with or interact with self-esteem and dominance, such that narcissism

predicts greater aggression most strongly among young men with lower self-esteem and when aggression is associated with instrumental motives, like dominance-striving (Barry, Frick, & Kilian, 2003; Brown & Zeigler-Hill, 2004; Kirkpatrick, Waugh, Valencia, & Webster, 2002; Steinberg, 1996; Washburn, McMahon, King, Reinecke, & Silver, 2004). While narcissism seems to be associated primarily with threat or insult-provoked aggression in interpersonal contexts (Baumeister, Bushman, & Campbell, 2000; Bushman & Baumeister, 2002), we have observed an association between narcissism and unprovoked attack in an experimental war game (Johnson et al., 2006).

As sex differences in aggression arise prior to puberty, early testosterone exposure is likely to be involved. Recent research has suggested the prenatal testosterone is associated with later aggressiveness in both non-human primates (Tomaszycki, Gouzoules, & Wallen, 2005) and in humans (Bailey & Hurd, 2005; Cohen-Bendahan, Buitelaar, van Goozen, Orlebeke, & Cohen-Kettenis, 2005). We predicted that sex differences observed in our experimental war simulation might be psychologically mediated by SDO, narcissism, and self-esteem. We tested this hypothesis using the ratio of the second-to-fourth finger length ratio (2D:4D) as a marker for early testosterone exposure (Cohen-Bendahan, van de Beek, & Berenbaum, 2005; Manning, Scutt, Wilson, & Lewis-Jones, 1998; McIntyre, 2006). Although the validity of 2D:4D as an early testosterone marker has not been fully established, related measures have a long history of use in research about early biological effects on assertiveness and competitiveness (Wilson, 1983).

2. Methods

This study involved 176 subjects who were recruited from a business school experimental subject pool, 76 women and 100 men. As 2D:4D has been shown to vary by race in addition to sex (Manning et al., 2000; McIntyre, Cohn, & Ellison, 2006), we asked subjects to report their race. Our sample had the following racial composition: 60% White, 20% Asian or Asian-American, 11% Black, 3% Hispanic, 1% Native American, and 5% Other. Ages ranged between 18 and 65 years, with a mean of 22 years.

We received human subjects permission for this experiment from the university institutional review board. All participants signed informed consent forms prior to their participation, and were told they could leave the study at any time without penalty, and were not deceived in the game. All subjects were volunteers who received cash payments of either \$20 or \$30, depending on how well they performed during the game. Subjects were randomly paired in either same-sex or mixed-sex dyads. Instructions asked them to role play the leader of a country in conflict with a neighbor over newly discovered diamond mines on disputed territory. The game was structured so that it was possible to win the game either by negotiating or by going to war and winning. However, going to war always entailed a non-zero probability of losing.

This game ran for six rounds, but subjects remained unaware of how many rounds the game would go until after they had finished. In each round, subjects undertook a number of different tasks. In the starting round, each person was given 100 million dollars, which was also given at the start of each successive new round. The subjects could keep that money as cash, they could buy army battalions with them for 10 million dollars a piece, or they could allocate their money into industrial units. The winner of the game was the one who ended up with the most industrial

production in her account at the end of the game, and received the additional \$10 in payment as agreed in advance.

In this paper, we focus on whether or not the player made an unprovoked attack during the course of the game. We define provocation as a prior attack by the counterpart player. In all dyads with at least one attack, the player attacking first committed an unprovoked attack. If both players attacked in the same round, each committed an unprovoked attack.

Before the game began, participants completed several standard inventories, the SDO (Pratto et al., 1994), the Rosenberg self-esteem scale (Rosenberg, 1965), the perceived stress scale (Cohen, Kamarck, & Mermelstein, 1983), and the Narcissistic personality inventory (Raskin & Terry, 1988), and gave photocopies of right and left hands. Digit lengths on photocopies were measured from the most proximal flexion crease to the fingertip for calculation of 2D:4D. A second author re-measured photocopies from 60 subjects. Reliabilities from 2D:4D were 0.925 on the left hand and 0.894 on the right hand.

We used χ^2 -tests, t -tests, and logistic regression, estimated in SPSS version 11.5, to test the effects of sex and 2D:4D on the commission of unprovoked attacks. In logistic regressions, 2D:4D was entered as a z-score, so that estimates of $\exp(B)$ reflect effects of one SD increase on odds of attack. Psychological measures were entered as quartile indicator variables (as low, medium, high, and very high), with the lowest quartile as referent. We expected an effect of sex based on the results of earlier experiments and wanted to test whether 2D:4D mediates the sex difference in unprovoked attack, and whether the effect of 2D:4D is itself mediated by personality. To exclude the possibility that effects of 2D:4D were confounded by racial differences, we also controlled for race in all analyses using indicator variables.

3. Results

The expected sex difference in unprovoked attack emerged. Of 100 men, 32 (32%) attacked without provocation, whereas only 11 (14%) of 76 women attacked ($\chi^2 = 7.18, p = 0.007$). Women had higher 2D:4D ratios, 0.014 greater in the left hand ($t = 2.90, p = 0.004$) and 0.013 greater in the right ($t = 2.34, p = 0.021$). Players who attacked without provocation also had 2D:4D values that were lower, more masculine, by 0.016 ($t = 3.03, p = 0.003$) on the right hand, but not on the left hand. Fig. 1 shows box plots of 2D:4D results by sex and attack history. Among women, the difference in 2D:4D between attackers and non-attackers was not significant (0.012, $t = 1.23, p = 0.237$). Whereas, among men, the difference was significant (0.015, $t = 2.35, p = 0.021$).

We intended to test whether personality measures mediated the effects of sex and 2D:4D on unprovoked attack. However, as shown in Table 1, the expected sex differences in narcissism and SDO were small and not significant. Table 2 shows the intercorrelation among personality measures separately in women and men.

Therefore, to control for confounding, we used logistic regression to estimate the independent effects of sex, right-hand 2D:4D, race, and personality measures (see Table 3). In all models, interaction terms were introduced but not significant and therefore removed. In the full main-effects model (Table 3, Model 1), sex and 2D:4D significantly predicted unprovoked attack. A likelihood ratio test comparing this model to an intercept-only model was significant. Variables were then removed in a stepwise fashion if a likelihood ratio test comparing a model without the variable

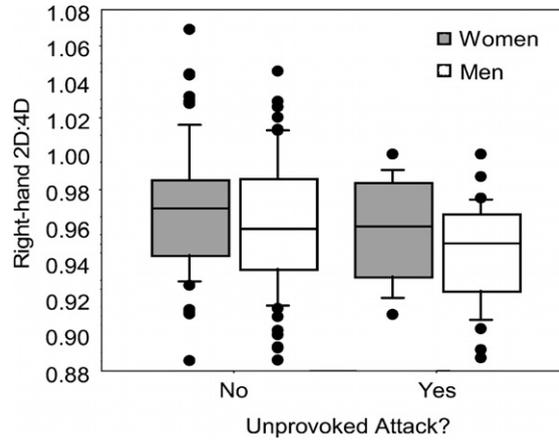


Fig. 1. Right hand 2D:4D by sex and whether an unprovoked attack was committed during a simulated war game.

Table 1
Scores on personality measures by sex and race, with ANOVA statistics

	<i>n</i>	Narcissism, <i>F</i> (<i>p</i>)		SDO, <i>F</i> (<i>p</i>) ^a		Self-esteem, <i>F</i> (<i>p</i>)		Stress, <i>F</i> (<i>p</i>)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
By Sex		1.8 (0.187)		1.5 (0.222)		6.1 (0.015)		5.7 (0.018)	
Women	76	11.0	4.5	41.3	13.1	22.5	4.8	24.9	6.9
Men	100	12.0	5.3	43.9	14.6	24.2	4.5	22.5	6.3
By Race		1.9 (0.137)		2.8 (0.041)		0.6 (0.625)		0.1 (0.980)	
White	105	11.5	5.0	43.6	13.3	23.3	4.8	23.4	6.5
Asian	36	10.5	5.0	45.6	17.8	23.1	5.2	23.7	7.4
Black	19	13.5	4.7	34.9	9.1	24.7	4.4	24.1	7.7
Others	16	12.6	4.2	40.4	11.3	23.9	3.2	23.8	5.3

^a Social dominance orientation.

Table 2
Intercorrelation among personality measures among women (above diagonal) and men (below diagonal)

	Self-esteem	Stress	SDO	Narcissism
Self-esteem		−0.63 ^a	−0.18	0.27 ^a
Stress	−0.50 ^a		0.14	0.00
SDO	0.03	−0.09		0.10
Narcissism	0.47 ^a	−0.39 ^a	0.30 ^a	

¹ Social dominance orientation.

^a *p* < 0.05.

to a model with the variable yielded *p* > 0.05. Sex and 2D:4D remained significant after stepwise reduction (Table 3, Model 2), as did the likelihood ratio statistic for the full model.

Table 3
Logistic regression models predicting unprovoked attack in all participants

<i>n</i> = 176	Model 1, -2 LL ^a = 162.6, <i>p</i> = 0.011			Model 2, -2 LL ^a = 183.0, <i>p</i> = 0.002		
	<i>B</i> (SE)	exp(<i>B</i>)	<i>p</i> value	<i>B</i> (SE)	exp(<i>B</i>)	<i>p</i> value
Sex (male)	0.89 (0.45)	2.43	0.049	-0.90 (0.40)	2.47	0.023
Std. 2D:4D	-0.43 (0.21)	0.65	0.041	-0.44 (0.20)	0.65	0.027
Narcissism						
Low	0.00	1.00	Referent			
Medium	0.21 (0.66)	1.24	0.745			
High	0.74 (0.67)	2.09	0.271			
Very high	0.86 (0.64)	2.37	0.174			
SDO ²						
Low	0.00	1.00	Referent			
Medium	-1.07 (0.57)	0.34	0.062			
High	-0.91 (0.57)	0.40	0.109			
Very high	-0.52 (0.55)	0.60	0.347			
Self-esteem						
Low	0.00	1.00	Referent			
Medium	0.33 (0.69)	1.38	0.636			
High	-0.10 (0.64)	0.91	0.877			
Very high	0.98 (0.64)	2.65	0.129			
Stress						
Low	0.00	1.00	Referent			
Medium	-0.74 (0.59)	0.48	0.215			
High	-0.39 (0.61)	0.68	0.522			
Very high	0.47 (0.59)	1.60	0.426			
Race (White)	-0.64 (0.66)	0.53	0.334			
Race (Asian)	-0.36 (0.75)	0.70	0.635			
Race (Black)	-0.24 (0.86)	0.79	0.785			
Race (Others)	0.00	1.00	Referent			
Constant	-1.40 (1.08)	0.25	0.195	-1.75 (0.33)	0.17	<0.001

² Social dominance orientation.

^a -2 Log Likelihood.

Among women, the full model was not significant ($-2 \log \text{likelihood} = 44.4$, $p = 0.297$), and the stepwise procedure did not yield any significant predictors of unprovoked attack. Among men, the full model was highly significant (see Table 4, Model 1). Moreover, after stepwise reduction, 2D:4D and three personality dimensions remained in the model: narcissism, SDO, and perceived stress (see Table 4, Model 2). In particular, adjusting for other covariates, men with narcissism scores in the third and fourth quartiles were 15 and 12 times as likely, respectively, to attack relative to men in the lowest quartile. However, the association with SDO and stress were not monotonic and contrary to predictions. The lowest quartile of SDO was associated with the highest likelihood of attack and intermediate-to-high SDO with the lowest likelihood. Similarly, both high and low perceived stress predicted attack, relative to intermediate scores.

Table 4
Logistic regression models predicting unprovoked attack among men

<i>n</i> = 100	Model 1, -2 LL ^a = 86.9, <i>p</i> < 0.001			Model 2, -2 LL ^a = 91.7, <i>p</i> < 0.001		
	<i>B</i> (SE)	exp(<i>B</i>)	<i>p</i> value	<i>B</i> (SE)	exp(<i>B</i>)	<i>p</i> value
Std. 2D:4D	-0.67 (0.31)	0.51	0.034	-0.62 (0.29)	0.54	0.032
Narcissism						
Low	0.00	1.00	Referent	0.00	1.00	Referent
Medium	1.66 (1.03)	5.23	0.107	1.58 (0.89)	4.85	0.075
High	2.77 (1.07)	15.92	0.010	2.71 (0.95)	14.96	0.005
Very high	2.46 (1.15)	11.70	0.032	2.52 (0.97)	12.43	0.010
SDO ²						
Low	0.00	1.00	Referent	0.00	1.00	Referent
Medium	-2.28 (0.91)	0.10	0.013	-2.02 (0.81)	0.13	0.013
High	-2.40 (0.94)	0.09	0.011	-2.32 (0.82)	0.10	0.005
Very high	-1.69 (0.86)	0.18	0.049	-1.62 (0.75)	0.20	0.030
Self-esteem						
Low	0.00	1.00	Referent			
Medium	-0.89 (0.97)	0.41	0.363			
High	-0.82 (0.83)	0.44	0.323			
Very high	0.56 (0.84)	1.75	0.502			
Stress						
Low	0.00	1.00	Referent	0.00	1.00	Referent
Medium	-1.90 (0.85)	0.15	0.025	-1.66 (0.80)	0.19	0.037
High	-0.54 (0.90)	0.58	0.546	-0.47 (0.78)	0.62	0.543
Very high	0.70 (0.84)	2.01	0.407	0.79 (0.75)	2.20	0.294
Race (White)	-0.46 (0.88)	0.63	0.599			
Race (Asian)	-0.44 (1.04)	0.64	0.669			
Race (Black)	-0.37 (1.31)	0.69	0.777			
Race (Others)	0.00	1.00	Referent			
Constant	-0.30 (1.41)	0.74	0.834	-1.00 (0.96)	0.37	0.294

² Social dominance orientation.

^a -2 Log Likelihood.

4. Discussion

We found evidence that low 2D:4D, a proposed anatomical marker of early testosterone exposure, predicted greater unprovoked attack in an experimental game simulating decisions about war. There was no suggestion that the effects of sex or 2D:4D were mediated or confounded by race or by any of the measured personality dimensions: narcissism, SDO, self-esteem, and stress, as effect estimates remained stable across models.

However, among men but not women, narcissism, SDO, and stress were independent predictors of unprovoked attack. As previously reported (Johnson et al., 2006), higher narcissism scores predicted substantially greater likelihood of attack. The associations with SDO and stress were curvilinear and difficult to interpret, with intermediate levels of both associated with lower likelihood

of attack. The curvilinear association with stress might indicate that either high or low arousal (Ramirez & Andreu, 2006) can predict aggression in this context.

Our results extend prior findings that early biological sex differentiation influences trait aggression to the context of a simulated war game. However, we did not find support for our predictions that narcissism and SDO, which are proposed as mediating similar sex differences in trait aggression, would mediate the sex difference in war game play. We have not assessed the association between unprovoked attack in our study and other measures of trait aggression, competitiveness or of aggressive or competitive behavior. Therefore the relevance of these results to those for other forms of aggressive personality or behavior cannot be fully established. That said, we also failed to observe significant sex differences in either narcissism or SDO, suggesting atypicality of our sample. Other sex-different personality dimensions, not measured in this study, might mediate the sex differences in unprovoked attacks or the effects of 2D:4D that we observed, including fear-related inhibition (Campbell et al., 1997; Driscoll, Zinkivskay, Evans, & Campbell, 2006), sensation-seeking (Aluja & Torrubia, 2004), gender identification (Dambrun, Duarte, & Guimond, 2004), or Big five agreeableness, which is also positively correlated with 2D:4D within sex (Luxen et al., 2005).

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