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Original Article

Digit Ratio (2D:4D) and Male Facial Attractiveness: New Data and a Meta-Analysis

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Abstract: Digit ratio (2D:4D) appears to correlate negatively with prenatal testosterone (T) effects in humans. As T probably increases facial masculinity, which in turn might be positively related to male facial attractiveness, a number of studies have looked into the relationship between 2D:4D and male facial attractiveness, showing equivocal results. Here, I present the largest and third largest samples so far, which investigate the relationship between 2D:4D and male facial attractiveness in adolescents (*n* = 115) and young men (*n* = 80). I then present random-effects meta-analyses of the available data (seven to eight samples, overall *n* = 362 to 469). These showed small (*r* ≈ -.09), statistically non-significant relationships between 2D:4D measures and male facial attractiveness. Thus, 2D:4D studies offer no convincing evidence at present that prenatal T has a positive effect on male facial attractiveness. However, a consideration of confidence intervals shows that, at present, a theoretically meaningful relationship between 2D:4D and male facial attractiveness cannot be ruled out either.

Keywords: attractiveness, mate choice, faces, 2D:4D, testosterone, meta-analysis

Introduction

Across cultures, good looks are valued in a potential partner (Buss et al., 1990) and facial attractiveness is an important component of overall physical attractiveness (Peters, Rhodes, and Simmons, 2007). Meta-analytic evidence suggests that facial attractiveness signals positive qualities, such as health, that are desirable in a mate (Langlois et al., 2000), and for this reason humans seem to have evolved to perceive and desire physical attractiveness (e.g., Grammer, Fink, Møller, and Thornhill, 2003). It has been argued that testosterone (T) levels depend on male condition in some species (Folstad and Karter, 1992); this line of thinking has been extended to humans, and it has been argued that T contributes to men's facial attractiveness (e.g., Roney, Hanson, Durante, and Maestripieri, 2006; Roney, Simmons, and Gray, 2011). In line with this view, a meta-analysis of the (fairly inconsistent) literature regarding the relationship between male facial masculinity and attractiveness found a moderate positive association (Rhodes, 2006). However, this view has been challenged in a recent review by Scott, Clark, Boothroyd, and Penton-Voak (2013), who argued that methodologically sound studies consistently demonstrate the absence of such a relationship.

Second (index) finger length divided by fourth (ring) finger length (2D:4D) appears to be a marker of prenatal T/estrogen levels and has been widely used to study prenatal T effects in humans (Manning, 2012). Lower 2D:4D are male-typical and indicate higher prenatal T levels (Berenbaum, Bryk, Nowak, Quigley, and Moffat, 2009; Hönekopp and Watson, 2010; Manning, Kilduff, and Trivers, 2013), and 2D:4D has been linked to certain male facial characteristics (Burriss, Little, and Nelson, 2007; Fink et al., 2005; Meindl, Windhager, Wallner, and Schaefer, 2012; Schaefer, Fink, Mitteroecker, Neave, and Bookstein, 2005). Recently, Ferdenzi, Lemaître, Leongómez, and Roberts (2011) reported substantial negative relationships between 2D:4D and facial attractiveness in a sample of 49 male students, thus suggesting an advantageous effect of prenatal T on male looks. Previously, Neave, Laing, Fink, and Manning (2003) also reported negative but small and non-significant relationships in a sample of similar size; recently, Roberts et al. (2011) reported positive relationships ($r \approx .10$, n.s.) in a small sample. Thus, evidence for a negative relationship between 2D:4D and male facial attractiveness appears equivocal. Here I report data from two considerably larger samples before I meta-analyze the available evidence in order to evaluate the idea that 2D:4D correlates negatively with male facial attractiveness.

Materials and Methods

Sample 1 consisted of 115 adolescents (mean age 17.2 years, $SD = 0.7$) recruited from secondary schools in Chemnitz (Germany) for a study on 2D:4D and sports performance (Hönekopp, Manning, and Müller, 2006). Sample 2 consisted of a community sample of 80 young men (mean age 22.4 years, $SD = 1.3$) from Chemnitz, recruited for the same study. All participants gave their informed consent.

In both hands, relevant finger lengths were measured three times from digital photographs by independent researchers who were unaware of all other data (more details can be found in Hönekopp et al., 2006). Reliability proved high (Cronbach's $\alpha \geq .91$). 2D:4D values reported here are based on the mean across the three measurements of the same fingers. In line with Ferdenzi et al. (2011), I report not only right-hand 2D:4D (2D:4Dr) and left-hand 2D:4D (2D:4Dl), but also the difference between the two (D_{r-l}), which has also been suggested to be inversely correlated with prenatal T effects (Manning, 2012).

Frontal facial photographs were taken against a neutral background from a distance of 1.5m at a resolution of 1024x1344 pixels. Participants in sample 2 removed glasses, wore a bathing cap to conceal hair and showed a neutral facial expression; these standardizations were not in place for sample 1 participants. Photos were cropped and resized to a standard height of 520 pixels. Female raters were approached on German university campuses and rated the face photographs on a 7-point scale, either for attractiveness (with endpoints anchored "not attractive" and "very attractive") or for masculinity (with endpoints anchored "not at all masculine" and "very masculine"). Pictures were presented in an individually randomized order on notebook computers. Twenty women (age range 17 to 55 years, M = 26.0, SD = 8.7) rated the sample-1 pictures for attractiveness and another 15 women (most of them in their early twenties) rated them for masculinity; 27 different women (age range 18 to 51 years, M = 25.6, SD = 6.6) rated the sample-2 pictures for attractiveness and another 17 (age range 18 to 26 years, M = 22.1, SD = 2.4) rated them for masculinity. Mean attractiveness and masculinity ratings for pictures were used in subsequent analyses (sample 1: attractiveness Cronbach's α = .93, masculinity Cronbach's α = .84; sample 2: attractiveness Cronbach's α = .89, masculinity Cronbach's α = .84). In this way, raters' menstrual cycle and pill use were not taken into account. However, cycle-dependent shifts in masculinity preferences are subtle (e.g., Penton-Voak et al., 1999) and should therefore not override any general association between men's facial attractiveness and their 2D:4D; further, aggregation of data across all female raters is in keeping with previous studies in this area (e.g., Ferdenzi et al., 2011) and is supported by the high levels of internal consistency observed here. The sample-2 rating data have been reported previously (Hönekopp, Rudolph, Beier, Liebert, and Müller, 2007), but not in relation to 2D:4D.

In order to statistically control for friendliness of expression in sample-1 pictures, six students and university staff rated to what extent all pictures showed a strong smile (-3 = "strongly disagree," 3 = "strongly agree"). Again, mean rating per picture (Cronbach's α = .91) was used in the analysis.

In order to identify relevant previous results for inclusion in the meta-analysis, I searched the *topic* field in *Web of Knowledge* for "attractiveness" in conjunction with either "digit ratio" or "2D:4D." Among the 52 hits were six studies that had collected relevant data. Three of them did not report any results on 2D:4D and male facial attractiveness. Corresponding authors were emailed about missing information; results for two out of the three aforementioned papers could be recovered in this way. I conducted random-effects meta-analyses (e.g., Schmidt, Oh, and Hayes, 2009) using Comprehensive Meta-Analysis (Version 2.2.064). A random-effects model takes into account that the estimated population effect size might not be a single value but might instead vary systematically with the type of sample, the methodology employed, or similar. Such heterogeneity is indicated by larger than expected variance in the effect sizes of primary studies. τ is the estimated standard deviation of the population effect size and therefore describes the magnitude of the observed heterogeneity; the Q statistic is used to test whether τ differs significantly from zero.

Results

Facial attractiveness and 2D:4D in two male samples

Descriptive statistics for digit ratio and rating data can be found in Table 1. Correlations between digit ratio measures, facial attractiveness, and facial masculinity can be found in Table 2. The sample 1 attractiveness data were corrected for smiling by using the residuals from regressions of attractiveness on smiling; however, zero-order correlations with digit-ratio measures were virtually the same (not shown). Data inspection confirmed that none of the results was unduly affected by outliers. In both samples, attractiveness correlated strongly with masculinity ($r \geq .58$). Correlations between digit ratio measures on the one side and ratings on the other side were all in the expected (negative) direction; however, correlations were small or near zero and none of them was statistically significant (all *p*s ≥ .060). Photographs showed a lower degree of standardization in sample 1 than in sample 2. I therefore looked at the sub-set of all 85 adolescents who did not wear glasses or any facial adornment. Compared to the full set results, correlations hardly changed (details not shown).[1]

Table 1. Descriptive statistics for digit ratio and facial attractiveness in males

	Sample 1		Sample 2	
	M	*SD*	*M*	*SD*
Right-hand 2D:4D	0.953	0.035	0.958	0.037
Left-hand 2D:4D	0.973	0.032	0.965	0.035
D_{r-l}	-0.020	0.032	-0.007	0.027
Attractiveness	3.1	0.0	2.5	0.6
Masculinity	4.7	0.7	3.5	0.6

Table 2. Correlations (with *p*-values) between 2D:4D, facial masculinity and facial attractiveness in two male samples

	2D:4Dl	2D:4Dr	D_{r-l}	Masculinity	Attractiveness
2D:4Dl		.56 (<.001)	-.39 (<.001)	-.01 (.922)	-.00 (.969)
2D:4Dr	.73 (<.001)		.55 (<.001)	-.12 (.196)	-.04 (.658)
D_{r-l}	-.29 (.009)	.45 (<.001)		-.13 (.179)	-.04 (.650)
Masculinity	-.01 (.916)	-.16 (.149)	-.21 (.060)		.58 (<.001)
Attractiveness	-.04 (.716)	-.18 (.105)	-.20 (.074)	.68 (<.001)	

Notes: Sample 1 (n = 115) above the diagonal, attractiveness scores corrected for smiling; Sample 2 (n = 80) below the diagonal.

Meta-analysis

The results from the primary studies into the relationship between 2D:4D and male facial attractiveness are listed, in decreasing order of sample size, in the upper part of Table 3. For 2D:4Dl and D_{r-l}, seven samples with altogether 362 participants were available; for 2D:4Dr, it was eight samples with altogether 469 participants. Apart from sample 1, participants were typically in their twenties. All studies used standardized facial

[1] Sample 1 also consisted of 183 females of the same age. As the focus is on male faces here, only a brief overview is provided: Attractiveness (Cronbach's α = .93) and rated femininity (Cronbach's α = .88) correlated highly (r = .79). Paralleling the results for males, none of the three 2D:4D measures (left, right, r-l) correlated with either rated femininity (r = .07, r = -.02, r = -.09, respectively; all *ps* ≥ .22) or attractiveness corrected for smiling (r = .04, r = .06, r = .02, respectively; all *ps* ≥ .39).

photographs which were rated by females, with the exception of Russell (2006), who used female and male attractiveness raters. Ferdenzi et al. (2011) was the only study that measured 2D:4D directly from the hands.

Table 3. Relationships between 2D:4D and male facial attractiveness in primary studies (top) and meta-analyses (bottom)

	Age (*M* ± *SD*)	*N*	2D:4Dl	2D:4Dr	D_{r-l}
Primary studies					
Sample 1	17.2±0.7	114	.00	-.04	-.04
Kościński (2012)	≈21.5	107		-.01[a]	
Sample 2	22.4±1.3	80	-.04	-.18	-.20
Neave et al. (2003)	21.3±3.4	48	-.23	-.06	.20[a]
Ferdenzi et al. (2011)	22.3±4.0	47	-.14	-.43[a]	-.34[a]
Russell (2006)	21.7±3.6	36	.12[a]	-.02[a]	-.22[a]
Roberts et al. (2011)	26.9±2.2	20	.12	.09	.03[a]
Russell (2006)	20.3±2.0	17	.17[a]	.11[a]	-.05[a]
Meta-analysis					
r (*p*)			-.03 (.537)	-.09 (.093)	-.10 (.150)
95% CI			[-.14, .07]	[-.20, .02]	[-.24, .04]
τ			0.00	0.07	0.11
Q(*df*)			4.1(6)	8.7(7)	9.0(6)
P			.658	.272	.171

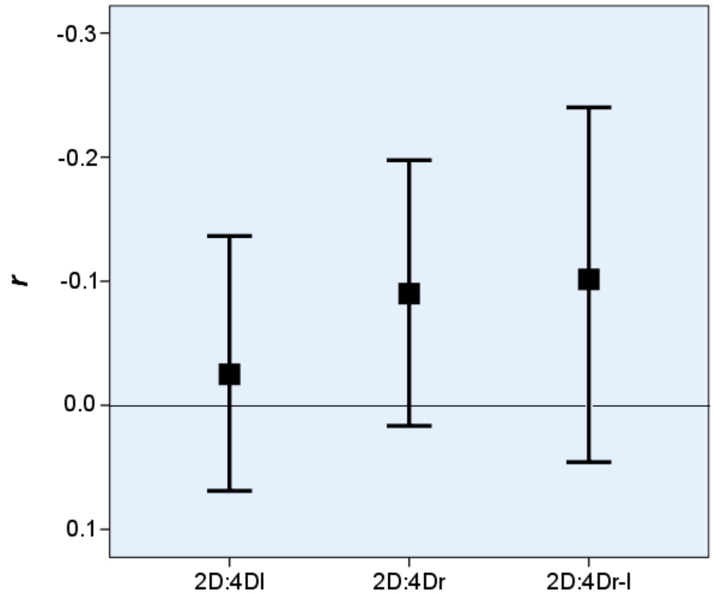
Notes: For primary studies, Pearson correlations are shown for the relationship between male facial attractiveness and 2D:4Dl, 2D:4Dr, and D_{r-l}. Personal communications are marked with [a]. Results for meta-analyses reflect (from top to bottom) mean effect size (point estimate with *p*-value, 95% confidence interval) and heterogeneity (point estimate, test statistic, *p*-value).

The bottom part of Table 3 and Figure 1 show the results from three meta-analyses (2D:4Dl, 2D:4Dr, D_{r-l}). For all three measures, small negative relationships emerged between 2D:4D and male facial attractiveness (largest for D_{r-l}: $r = -.10$). All 95% confidence intervals contained zero, thus results were not statistically significant.

Discussion

In two samples, negative relationships between 2D:4D and male facial attractiveness emerged; however, these relationships were weak and not statistically significant, although sample sizes were large in comparison to most studies in the field (cf. Table 3). Any link between attractiveness and 2D:4D should be mediated by facial masculinity (Ferdenzi et al., 2011), but a positive relationship between attractiveness and measured masculinity is not consistently found (DeBruine, Jones, Smith, and Little, 2010; Rhodes, 2006; Scott et al., 2013). Here, however, strong relationships emerged with rated masculinity ($r \approx .60$). Thus, the observed lack of association between 2D:4D and attractiveness was down to weak associations between rated masculinity and 2D:4D in both samples ($r \approx -.10$, n.s.).

Figure 1. Meta-analyses' estimates of population correlations between 2D:4D and male facial attractiveness, with 95% confidence intervals



Some limitations of the studies should be taken into consideration. Sample 1 photographs were not highly standardized. However, neither the statistical correction of attractiveness for smiling nor the exclusion of models wearing glasses or facial adornment changed the results, which suggests that lack of standardization did not cause major problems. Another point is that, due to age differences, many of the attractiveness raters would probably not consider the models as potential partners (especially for sample 1). However, averaged ratings of facial attractiveness appear to be similar across different groups of raters (Langlois et al., 2000) and, considerable variation of rater age notwithstanding, the internal consistency of averaged attractiveness ratings was high in both samples (Cronbach's $\alpha \geq .89$).

A meta-analysis of the available data revealed small negative relationships ($r \approx -.07$) between male facial attractiveness and 2D:4Dl, 2D:4Dr, and $D_{r-l.}$ None of the effects were statistically significant; thus the findings available to date offer no convincing support for a relationship between 2D:4D and male facial attractiveness.

The relationship between 2D:4D and male facial attractiveness is of interest because 2D:4D likely tracks prenatal T effects (e.g., Manning, 2012; Manning et al., 2013). Studies comparing 2D:4D between groups of people who differ in prenatal T effects (females versus males; people affected from congenital adrenal hyperplasia, complete androgen insensitivity syndrome, or Klinefelter's syndrome versus unaffected controls) consistently found that the group differences in 2D:4D are substantially smaller than the group differences in prenatal T effects (Berenbaum et al., 2009; Hönekopp and Watson, 2010; Manning et al., 2013). This suggests that 2D:4D and prenatal T levels might not correlate very highly. Therefore, relationships between 2D:4D and characteristics of interest might be substantially attenuated in comparison with prenatal T effects on these characteristics (e.g., Kline, 2005). Consequently, even a small relationship between 2D:4D and male facial attractiveness would be of theoretical interest. We should bear this in mind when judging the CIs (cf. Figure 1), which indicate the range of plausible estimates for the correlation in the population (Cumming, Fidler, Kalinowski, and Lai, 2012). For example, I would certainly regard a correlation of r = -.20 as meaningful in the present context, and this is still captured in two out of the three CIs. Thus, support for the null hypothesis does not seem very strong.

In sum, though, the data do not support an effect of prenatal T on male facial attractiveness. This is in line with the view that facial masculinity and attractiveness are largely independent and that the former is more important in the context of intra-sexual competition than in mate choice (Puts, 2010; Scott et al., 2013).

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