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Digit ratio (2D:4D) and sensation seeking: New data and meta-analysis

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ABSTRACT

Previously reported associations between low (male-typical) digit ratio (2D:4D), a putative pointer to prenatal testosterone exposure, and high (male-typical) sensation seeking have been inconsistent across studies (alternately present for men, women, either sex, or neither). Addressing this question again in three new studies (N = 198, 188, 1118) produced similarly erratic findings. Meta-analysis of the entire literature (13 studies with nearly 3000 individuals, including unpublished accounts) showed that the current cumulative evidence does not support any negative correlations between 2D:4D and sensation seeking traits. The only significant meta-analytical finding was for right-hand 2D:4D and the experience seeking facet of sensation seeking in both sexes, but this effect accounted for merely 0.4% attributable variance, and moreover was directionally opposite to expectation (i.e., a positive correlation). Discussed are inherent limitations of narrow-scoped approaches (such as via 2D:4D) for elucidating the biological bases of individual difference variables with evidentially intricate neurochemical underpinnings (such as sensation seeking).

1. Introduction

Sensation seeking is an important and thus widely studied biosocial dimension of personality (Zuckerman, 1979, 1994, 2007). According to Zuckerman's (1994) hierarchical conception, this broad trait is composed of four narrower subfactors or facets: thrill and adventure seeking (TAS), disinhibition (DIS), experience seeking (ES), and boredom susceptibility (BS). TAS taps more socially accepted types of sensation seeking behavior (e.g., risk-taking sports and activities), and a need for novel stimuli in general; DIS less socially accepted behaviors (e.g., drinking, partying, gambling, and promiscuous sex), and a need for intense stimuli in general; ES sensation seeking through the mind and senses, and openness to novel experiences in general; and BS aversion for repetitive experience of any kind, and restlessness in general.

Sex and age are the most marked demographic correlates of sensation seeking, and in this regard the trait is unlike most other personality dimensions (Zuckerman, 1994). Sensation seeking is higher in men than in women, and this commonly found sex difference is particularly strong for TAS and DIS, whereas evidence is mixed for ES, and BS shows the least sex difference or a lack of it. Increasing in adolescence and peaking in late adolescence or the early twenties, sensation seeking declines steadily with age thereafter (again, particularly strongly for TAS and DIS). Such changes over the adult years are not typical for most personality traits. Also, there is evidence for strong genetic bases of sensation seeking, approaching 70% of additive genetic variance corrected for unreliability, which figure is at the high end of the range for personality traits (Zuckerman, 1994). The conspicuous sex and age differences in sensation seeking, along with its high heritability, suggest a role of gonadal hormones, particularly testosterone, in biological explanations. Circulating testosterone levels are much higher in men than in women, decline with age, also show substantial heritability, and indeed have been found to be positively correlated with sensation seeking (Daitzman & Zuckerman, 1980; Daitzman, Zuckerman, Sammelwitz, & Ganjam, 1978).

This evidence has prompted further investigations into possible contributions of early sex-hormonal effects on sensation seeking. A now widely studied putative retrospective marker for prenatal, permanently masculinizing, testosterone effects is the second-to-fourth digit ratio (2D:4D) (Voracek & Loibl, 2009). Men have lower 2D:4D than women, which sex difference emerges prenatally and appears developmentally fairly stable (Manning, 2002). However, the scientific record on possible prenatal effects of testosterone on sensation seeking in adults is inconsistent. Some theory compliant (i.e., negative) correlations between 2D:4D and sensation seeking were obtained in three studies (in women, but not in men: Austin, Manning, McInroy, & Mathews, 2002; in men, but not in women: Fink, Neave, Laughton, & Manning, 2006; in both men and women: Hampson, Ellis, & Tenk, 2008), whereas no such effects in a fourth study (Schwerdtfeger & Heer, 2008).

Such a state of affairs is not uncommonly observed in 2D:4D research, a field for which publication bias is suspected (Vehmas, Solovieva, & Leino-Arjas, 2006) and wherein there is a dearth of meta-analyses (Hönekopp, Bartholdt, Beier, & Liebert, 2007; Puts,

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McDaniel, Jordan, & Breedlove, 2008). The inconsistent findings across the above four studies may or may not cancel each other out, and there might be additional unpublished data that should be considered as well. The aim of the present research was therefore to address this question anew, with novel, multisample data, and to subject the entire literature to a meta-analysis.

2. Study 1

This initial study, as well as those following, investigated possible associations of 2D:4D and sensation seeking anew. Age is a negative correlate of all four sensation seeking facets, and the facets are throughout positively interrelated. Only one study (Fink et al., 2006) controlled associations of sensation seeking facets with 2D:4D for possible distortional effects of the first fact, whereas none for the second one. Because of the lack of knowledge regarding possible confounding effects of these two facts, controls were provided for both.

2.1. Method

2.1.1. Participants

Participants were 84 men and 114 women (ages: 16–80 years, $M = 26.5$, $SD = 10.5$), all of them self-reported heterosexuals and native Austrians, who volunteered for this research.

2.1.2. Measures

The German form (Beauducel, Strobel, & Brocke, 2003) of the Sensation Seeking Scale, Form V (SSS-V; Zuckerman, 1994), the most widely used self-report measure in this research area, was administered. In this multiscale instrument, the four construct facets (TAS, DIS, ES, BS) are represented in balance with 10 items each, which require forced choices between opposed statements (trait-indicative vs. not).

2.1.3. Procedure

Participants were approached at copy shops outside, but nearby, university facilities. This way, a sizable number of nonstudents were recruited. After participants reported basic demographic information and completed the SSS-V, palmar-view, life-size (i.e., scale 1:1) photocopies of their right and left hands were taken, following standard procedures of 2D:4D research (Voracek, Manning, & Dressler, 2007). Three experienced, mutually blinded investigators measured finger lengths, using digital vernier calipers accurate to 0.01 mm. Measurement landmarks were the midpoint of the ventrally located proximal-most metacarpophalangeal flexion crease (separating the finger from the palm) and the finger tip. Averaged triplicate measurements were used to calculate right-hand and left-hand digit ratio (R2D:4D and L2D:4D).

2.2. Results and discussion

In common with the literature (Manning, 2002), digit ratio measurements were highly repeatable, and men had significantly lower digit ratios than women, which sex effect was medium-sized and more pronounced for R2D:4D than for L2D:4D (Table 1). Similarly, men exhibited significantly higher total SSS-V, TAS, and DIS (but not ES and BS) scores than women. Replicating further knowns from sensation seeking research (Zuckerman, 1994), all four SSS-V subscales were significantly positively interrelated, ranging from $r = .22$ ($p = .002$; DIS–BS) to .31 ($p < .001$; TAS–ES), and all subscales as well as total scores showed significantly negative correlations with age, ranging from $r = .22$ ($p = .002$; ES) to $-.33$ ($p < .001$; DIS).

Table 1
Sex differences in study variables.

	Men		Women		α	t	d
	M	*SD*	*M*	*SD*			
R2D:4D	0.952	0.029	0.974	0.037	.96***	−4.42***	−0.65
	0.960	0.031	0.970	0.032	.98***	−2.02*	−0.32
	0.952	0.029	0.967	0.032	.96***	−8.34***	−0.49
L2D:4D	0.959	0.029	0.970	0.035	.96***	−2.39*	−0.34
	0.960	0.028	0.966	0.034	.98***	−1.44	−0.19
	0.959	0.031	0.970	0.035	.96***	−5.54***	−0.33
SSS-V TAS	5.7	2.4	4.3	2.2	.64	4.16***	0.61
	30.4	10.8	24.6	11.5	.83	3.43**	0.52
	32.2	10.1	26.1	10.4	.82	9.80***	0.59
SSS-V DIS	6.1	1.7	5.2	1.8	.58	3.47**	0.51
	23.3	8.8	20.5	8.0	.74	2.30*	0.34
	26.6	8.0	21.8	8.0	.74	9.93***	0.60
SSS-V ES	6.3	2.3	6.2	1.9	.48	0.47	0.05
	28.5	8.2	29.8	7.8	.63	−1.02	−0.16
	28.8	8.6	29.1	7.9	.68	−0.51	−0.04
SSS-V BS	2.8	1.8	2.9	1.9	.39	−0.24	−0.05
	21.3	6.5	17.6	7.2	.56	3.61***	0.53
	26.1	6.1	23.2	6.5	.48	7.51***	0.46
SSS-V total	20.9	5.1	18.5	4.8	.71	3.30**	0.49
	103.6	23.0	92.4	24.5	.84	3.10**	0.47
	113.6	25.0	100.2	23.9	.86	9.15***	0.55
AISS novelty	17.4	4.8	16.7	4.4	.50	1.04	0.15
AISS intensity	13.0	4.8	10.4	4.5	.61	3.76***	0.56
AISS total	30.4	8.1	27.1	7.8	.70	2.81**	0.42

Line 1, 2, 3 entries = studies 1, 2, 3 (AISS used in Study 2 only).
α = internal consistency for psychometric measures, whereas absolute-agreement intraclass correlation (Voracek et al., 2007) for finger-length measures.
* $p < .05$.
** $p < .01$.
*** $p < .001$ (two-tailed).

Among men, SSS-V subscale and total scores were, for the most part, slightly negatively, but throughout not significantly, related to 2D:4D (Table 2). Controls for age (for total scores) or for age and the respective three other subscale scores (for each of the four subscales) left this pattern essentially unchanged. The only significant findings were negative correlations between R2D:4D and BS (only with controls for age and the other subscales) and between L2D:4D and BS (both the zero-order and the partial correlation) among women. With these few significant, theory compliant (negative) correlations of 2D:4D and sensation seeking among women, but a lack of significant correlations among men, altogether the findings of Study 1 most closely resembled those of Austin et al. (2002).

3. Study 2

One potential reason for the modest, inconclusive findings of Study 1 could be the mediocre to low SSS-V subscale reliabilities (a common finding; Zuckerman, 1994). This would attenuate any real effects. The SSS-V forced-choice format has been criticized repeatedly (e.g., Arnett, 1994), and one brief form derived from the SSS-V (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002) uses a Likert-type instead of the true-false response format. In order to increase scale reliability, in Study 2 the forced-choice format of the opposed SSS-V item pairs was amplified to a bipolar, 6-point scale (0 and 5: *Totally agree*, 1 and 4: *Fairly agree*, 2 and 3: *Somewhat agree*).

Of note, a distinctly different conception of sensation seeking due to Arnett (1994) foregrounds the need for novelty and intensity of stimulation (i.e., emphasizes sensory over situational stimulation), instead of the need for novelty and complexity of