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Second-to-fourth digit length ratio as a measure of harm avoidance

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ABSTRACT

Research on the associations between the ratio of second-to-fourth digit lengths (2D:4D ratio) and psychological variables could be a useful method of confirming sex hormone effects on human behavior tendencies. This study investigated the correlations between the 2D:4D ratio and characteristics of temperament and character in an urban community population. We hypothesized that the 2D:4D ratio correlates more strongly with temperament than with character. A total of 728 healthy adults (330 men and 398 women) ranging in age from 20 to 45 years were tested. Subjects completed the Temperament and Character Inventory (TCI) and were examined by measuring the 2D:4D ratio using a direct measurement method. Correlations between the 2D:4D ratio and psychological characteristics were explored. For women only, significant positive correlations with the 2D:4D ratio were found in the TCI-Temperament dimension (TCI-T), particularly in the two subscales of harm avoidance scale. Women with higher 2D:4D ratios had higher fear of uncertainly scores ($r_{partial} = 0.206$, $p = 0.028$) and shyness with strangers scores ($r_{partial} = 0.252$, $p = 0.024$). The 2D:4D ratio shows stronger correlations with temperament than with character. A higher 2D:4D ratio of woman is expected to indicate harm avoidance.

1. Introduction

Second-to-fourth digit length ratio (2D:4D ratio) is known to be sexually dimorphic, with mean values being lower for men than for women (Manning et al., 2000). For decades, the sex difference in the 2D:4D ratio has been recognized (Baker, 1888), but the 2D:4D ratio has attracted attention only in recent years, with the viewpoint that it might represent a biological marker of the degree of somatic masculinization by prenatal sex hormones (testosterone and androgen) (Zheng & Cohn, 2011).

The 2D:4D ratio is related to person's exposure to prenatal sex hormones. The 2D:4D ratio is negatively associated with prenatal testosterone exposure. It is uncertain when completion of the 2D:4D ratio occurs. Recent studies suggest that the 2D:4D ratio is fixed until the end of the first trimester (14th week of pregnancy) (Malas, Dogan, Hilal Evcil, & Desdicioglu, 2006). Within that period, the fetus is systematically affected by testosterone (Talarovičová, Kršková, & Blažeková, 2009). Once the 2D:4D ratio is fixed, that is unchanged for life, regardless of sex hormone exposure after birth or the major hormone changes that occur during puberty (Auger et al., 2013). Therefore, the 2D:4D ratio can be an indicator of prenatal testosterone exposure.

The effect of testosterone on the 2D:4D ratio is reflected in individual differences within each sex. Ideally, the individual difference in the 2D:4D ratio within each sex could develop via a separate mechanism, but it appears likely that they reflect the level of prenatal testosterone exposure. Individuals of either sex who were strongly exposed to prenatal testosterone tend to have lower 2D:4D ratios (Fink, Manning, & Neave, 2004).

Research on the associations between the 2D:4D ratio and psychological variables, such as personality traits or behavioral patterns, could be one of the most convenient and useful methods of confirming the effects of sex hormones on human behavior tendencies. The measurement of the 2D:4D ratio is technically simple, clear, and ethically less problematic. Since the 2D:4D ratio is less variable between individuals, it has high re-test credibility. The analysis of the association of the 2D:4D ratio with personal characteristics may require diverse study methodologies.

According to the Cloninger's psychological model on the development of personality (Cloninger, 1999; Cloninger, Svrakic, & Przybeck, 1993), personality is composed of temperament and character. Temperament is defined as an automatic tendency to emotionally respond to external stimuli. It is mainly hereditary and innate, and remains stable during a person's lifetime. Temperament is the raw material or frame for personality development. On the other hand, character is defined as an individual difference in goals, values, and self-concepts (self-understanding and identification). It is acquired, learned, and developed continuously during a person's lifetime. Character is affected by the environment and sociocultural learning. Character is

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formed based on its raw material — temperament, and constitutes the personality with temperament. In conclusion, character regulates innate temperament responses, and temperament can be expressed in various ways by character.

Prenatal exposure to testosterone is expected to be associated more with temperament than with character. If the 2D:4D ratio is associated with psychological characteristics, its associations with temperament may be more significant than with character, because the 2D:4D ratio is fixed regardless of sex hormone exposure after birth. Many studies have been described the associations between psychological characteristics and 2D:4D ratios. However, these studies did not consider the temperament and character separately. The current study was carried out to investigate the correlation between the 2D:4D ratio and characteristics of temperament and character in an urban community population. Specifically, it was hypothesized that the 2D:4D ratio correlates more strongly with temperament than with character.

2. Method

2.1. Subjects

A total of 728 healthy adults in multiple community health centers were enrolled in this study between April 2011 and December 2014. Subjects were 330 men and 398 women, ranging in age from 20 to 45 years. The maximum age of subjects was limited to 45 years, as the 2D:4D ratio increases slightly with age (Williams, Greenhalgh, & Manning, 2003), and seniors are more likely to have deformation of skin or joints in hand. The mean age of the men subjects was 33.25 ± 7.44 years and that of the women subjects was 29.68 ± 6.77. The participating centers were Yangju City Community Health Center (n = 330), Icheon City Community Health Center (n = 211), and Seoul Public Health Center (n = 187).

Subjects who were confirmed to have suffered from chronic physical and mental diseases through a self-developed questionnaire, and who could not complete the measurements were excluded. The questionnaire consists of six items to identify subjects' medical history and psychiatric history (e.g., have you been prescribed a medicine for an underlying medical disease? If so, what is the medical diagnosis?) Subjects who reported injuries to the second or fourth digits were also excluded. All subjects were informed of the details of this study and provided written consent before their participation. The institutional review board of each community health center approved the study.

2.2. Procedure

Subjects were asked to fill out the Temperament and Character Inventory (TCI). We chose to measure finger length directly (i.e., from the fingers themselves) rather than indirectly (i.e. from photocopies or scans). Manning, Fink, Neave, and Caswell (2005) reported that indirect 2D:4D tends to be lower than direct, and this effect is greatest in males. This means that compared to direct 2D:4D, the indirect image of the hands influences the relative length of the 2nd and 4th fingers such that the 2nd finger appears to be shorter than the 4th. This finding of a directional effect of indirect 2D:4D which is influenced by sex has been replicated by a number of groups (e.g. Almasry, El Domiaty, Algaidi, Elbastawisy, & Safwat, 2011; Hönekopp & Watson, 2010; Shaw, Kotowski, Boster, & Levine, 2012). The directional effect has been challenged by Voracek and Dressler (2006) who reported that the direct 2D:4D ratio was lower (not higher) than the indirect 2D:4D ratio. However, this conclusion was examined in a meta-analysis of Southeast Asian (Chinese) studies by Xu and Zheng (2015). The findings suggested that Voracek and Dressler's results were incorrect.

We measured only right hand digit length. Many studies have revealed that the sexual dimorphism of digit ratio is stronger in the right hand in human (Hönekopp & Watson, 2010). Several studies have suggested that androgen-testosterone affects the right hand more than the left (Manning, Scutt, Wilson, & Lewis-Jones, 1998). Furthermore, many studies have reported that relationships between digit ratios and psychological factors are stronger for the right hand, or found on the right hand only (Williams et al., 2000).

The lengths of the second and fourth digits were directly obtained by measuring the shortest distance in 0.01 mm increments between the ventral proximal crease of the digit and the fingertip using a digital Vernier caliper. If there was a band of creases at the base of the digit, we measured from the most proximal of these. This measure was conducted by two independent researchers, and the intra-class correlation coefficient (ICC) of which was 0.87, indicating excellent inter-rater reliability. This measure was repeated twice at 1- or 2-week intervals in 39 subjects to assess measurement repeatability. The difference in digit ratios between the first and second measurements was not significant ($t(38) = -1.50$, $p = 0.16$)), and provided good reliability.

2.3. Temperament and Character Inventory (TCI)

The TCI (Cloninger, Przybeck, & Svrakic, 1994) comprises 140 items to be answered with 0 for "Absolutely not," 1 for "No," 2 for "Neutral," 3 for "Yes," or 4 for "Absolutely, yes." Evaluations were conducted using seven scales, which included four TCI-Temperament scales (TCI-T) and three TCI-Character scales (TCI-C), with 16 and 13 subscales, respectively. TCI-T was used to evaluate novelty-seeking (NS), harm avoidance (HA), reward dependence (RD), and persistence (P). TCI-C assessed self-directedness (S), cooperativeness (C), and self-transcendence (ST). TCI is widely used to measure personal characteristics considering the congenital temperament and the acquired character separately. TCI has been validated in many studies and translated into several languages (Miettunen, Kantojärvi, Veijola, Järvelin, & Joukamaa, 2006). In this study, the Korean version of the TCI was used. Cronbach's alpha values of the Korean version of the TCI ranged from .60 to .85 for the temperament scales and from .82 to .87 for the character scales. Test–retest correlations (r) ranged from .52 to .72 for the temperament scales and from .52 to .71 for the character scales (Sung, Kim, Yang, Abrams, & Lyoo, 2002).

2.4. Statistical analyses

Parametric methods were used after identifying whether the data followed a Gaussian distribution. T-tests were used to confirm the difference in the 2D:4D ratios between men and women. Analysis of variance was used to identify age group differences in the 2D:4D ratios within each sex. Sexual dimorphism in TCI scores was presented using effect size (d) and analyzed by t-test. Associations between the 2D:4D ratios and temperament and character were subjected to Pearson's correlation. Differences between the women and men groups following Bonferroni corrections were considered significant at $p < 0.025$.

3. Results

3.1. 2D:4D ratios by sex and age

The mean right-hand 2D:4D ratio of the men and women was 0.9518 ± 0.0308 and 0.9763 ± 0.0283, respectively. There were seven women whose 2D:4D ratios were 3 SD below the mean of the women presenting lower bound of the men's range. The data of these seven women's were removed from the analysis. The 2D:4D ratios in women were significantly higher than those in men ($t = -3.48$, $p < 0.001$). This sexual dimorphism was also significant ($p < 0.001$) in each age group (20 to 29 years, 30 to 39 years, and 40 to 45 years). The 2D:4D ratio increased slightly with higher age group in each sex (Table 1). However, analysis of variance of the three age groups within each sex did yield not significant results.