Personality and Individual Differences 46 (2009) 424–427

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

The influence of digit ratio on the gender difference in learning style preferences

Cagla A. Isman *, Nimet U. Gundogan

Department of Physiology, Baskent University, Faculty of Medicine, Baglica Campus, Ankara 06530, Turkey

A R T I C L E I N F O

Article history:
Received 4 August 2008
Received in revised form 7 November 2008
Accepted 12 November 2008
Available online 20 December 2008

Keywords:
Digit ratio
Fetal testosterone
Gender
Learning preference
VARK
Medical education

A B S T R A C T

Fetal testosterone has been shown to affect the areas in the brain that are critical for learning and memory. The present study was designed to investigate if prenatal testosterone exposure is a candidate for having a causal role in sexual dimorphism observed in learning style preferences. A total of 183 students (mean age: 20.65 ± 2.42) from a population of 247 (74%) were enrolled in the study. Learning style preference was determined via the Turkish version of the learning style inventory, and the digit lengths of both hands were measured using digital calipers. Unimodal learning was more frequent among males (30.6% vs. 17.1%; p < 0.01). There was no marked difference in learning styles with respect to age. Digit ratio (2D/4D) of both hands was determined to be significantly lower in males, when compared to females ($p < 0.001$). Lower 2D/4D ratios were determined to be associated with unimodal learning significantly in both genders. In conclusion, represented by digit ratio (2D/4D) as a proxy marker, prenatal testosterone exposure may have a causal role in the sexual dimorphism observed in learning style preferences.

1. Introduction

Prenatal levels of sex steroids can influence the structure and function of the central nervous system (Collaer & Hines, 1995). Fetal testosterone has been shown to affect areas in the brain that are critical for learning and memory such as the hippocampus, hypothalamus, amygdala, and prefrontal cortex (Grumbach, Hughes, & Conte, 2003; Martini, Melcangi, & Maggi, 1993). By means of this, fetal testosterone in the circulation can modulate not only sexual behavior but also the ability of the brain to process, store, and retrieve sensory information (Genazzani, Pluchino, Freschi, Ninni, & Luisi, 2007).

It is difficult to design studies concerning organizing effects of prenatal testosterone on the human fetal brain (Cohen-Bendahan, van de Beek, & Berenbaum, 2005; Collaer & Hines, 1995) due to apparent ethical and practical reasons. That is why the determination of the ratio of the second to fourth finger lengths (or 2D:4D ratio) (Manning, Scutt, Wilson, & Lewis-Jones, 1998) has become popular as a means to study the effects of prenatal androgenization in humans. So far, digit ratio (2D:4D) is the best known physiological proxy marker of prenatal hormonal exposure (Manning et al., 1998). Digit ratio (2D:4D) has been described to be a sexually dimorphic trait with lower mean 2D:4D in males compared to females (Manning, 2002), and has been known to exist from at least two years of age, and is possibly established even earlier (Manning et al., 1998).

Learners perceive, process, store, and recall what they are attempting to learn in the most effective and efficient manner depending on their specific learning style preferences (James & Gardner, 1995). Preference in learning style was determined in the present study using the model developed by Fleming (1995), based on the sensory modality by which a student prefers to take in new information. According to this perceptual and instructional model (VARK), visual (V), auditory (A), reading/writing (R/W), and kinesthetic (K) styles are the four major sensory modes of learning, which operate depending on the neural system preferred by the learner. Visual learners learn through seeing flow charts, hierarchies, drawings, pictures, and other image-rich teaching tools. Auditory learners learn by listening to lectures, exploring material through discussions, tutorials, and talking through ideas. Reading/writing learners learn through interaction with textual materials, lists, dictionaries, whereas kinesthetic learners learn through touching and experiences that emphasize doing, physical involvement, and manipulation of objects (Fleming, 1995).

Unimodal learners prefer a single learning style, whereas individuals preferring a variety of styles are known to be multimodal learners who are classified as bi-, tri-, and quadmodal learners, according to their use of two, three, or four styles, respectively (Wehrwein, Lujan, & DiCarlo, 2007).

Despite conventional educational approaches assuming that learners are uniform in processing and organizing information (Arthurs, 2007), recent studies have shown that students learn in different ways reflecting their distinct learning styles (Lujan & DiCarlo, 2006).

* Corresponding author. Tel.: +90 312 2341010; fax: +90 312 2341180.
E-mail address: caglaism@yahoo.com (C.A. Isman).

0191-8869/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.paid.2008.11.007

Gender is among the factors (age, academic achievement, brain processing, culture, and creative thinking) that are known to influence individual learning styles (Honigsfeld, 2001). In fact, there is a biological basis for the gender differences observed in learning preferences. Equally dramatic dissimilarities were shown for gender differences in brain functioning just as the physical differences observed between male and females. The developing brain is permanently and irreversibly transformed during intrauterine life in such a way that postnatal experiences will not change the gender of the brain at birth from male to female, or vice versa (Lacoste, Holloway, & Woodward, 1986; Achiron, Lipitz, & Achiron, 2001).

Studies concerning the gender difference in the brain structure, which leads to difference in perceptions, priorities, and behavior of males and females through distinct information processing (Moir & Jessel, 1992), have consistently reported the presence of more hemispheric asymmetry, lesser concentration of grey matter in the neocortex, and more grey matter in the entorhinal cortex in male brains compared with female brains (Cordero, Valenzuela, Torres, & Rodriguez, 2000; Good et al., 2001; Rabinowicz et al., 2002). Also, different areas of the brain were found to be active, when women and men engage in particular activities such as processing information, listening, reading, and experiencing emotion (Phillips, Lowe, Lurito, Dzemidzic, & Matthews, 2001; Shaywitz, Shaywitz, et al., 1995).

However, elsewhere in the literature, the association between gender and learning preferences was inconsistent. Assessment of medical students from two medical faculties for gender difference in learning style preference in these studies revealed that 54.2% of females and only 12.5% of males preferred a single mode of information presentation in a faculty (Wehrwein et al., 2007), while a similar percentage of males (56.1%) and females (56.6%) were determined to prefer information to reach them via multiple sensory modalities in the other faculty(Slater, Lujan, & Di Carlo, 2007).

When the sexes were compared in terms of sensory process, women were found to show a greater sensitivity to sound, see better in the dark, and have a better visual memory. (Moir & Jessel, 1992). Since women have such superiority in so many of the senses enabling them to be better equipped to notice things to which men are completely blind and deaf, expecting a gender difference in unimodal vs. multimodal learning preferences seems to us to be pertinent.

Based on the modulatory role of fetal testosterone on the ability of the brain to process, store, and retrieve sensory information and the controversial data concerning the modulatory role of gender on learning, the present study was designed to investigate if prenatal testosterone exposure is a candidate for having a causal role in sexual dimorphism observed in the learning style preferences.

2. Methods

2.1. Subject population

Of 247 students at Baskent University Faculty of Medicine, a total of 183 students (74.0%) were recruited for the study upon their voluntary participation. The Turkish version of the VARK questionnaire was applied via face to face interview method, and the digit ratio measurements were performed from 3rd March to 25th March, 2008.

2.2. Digit ratio (2D/4D) measurement

Digit ratio for right and left hand was measured according to the method described by Manning et al. (1998). The length of the second and fourth digits was measured on the ventral surface of the hand from the basal crease of the digit proximal to the palm to the tip of the digit with digital calipers measuring to 0.01 mm (Manning et al., 1998). The digit ratio was calculated by dividing the length of the second digit by that of the fourth digit (2D:4D).

2.3. VARK questionnaire

The VARK questionnaire was developed by Fleming (1995) has been used to identify the sensory modality, by which students prefer to take the information. The VARK questionnaire is a 13-item, self-reported, multiple choice questionnaire that can be completed in 10–15 min. Besides being a practical and user friendly method for the evaluation of preferred modes of information transfer, the VARK questionnaire is also available online. Scoring of the results was done according to the instructions and sample charts available on the website addressed in the past studies (Lujan & DiCarlo, 2006; Slater et al., 2007; Wehrwein et al., 2007). Despite lacking statistical validation, which represents a limitation of this study, the strength of the VARK lies in the fact that questions are drawn from real life situations and people identify with the results that they receive—that is, they affirm the face validity of the tool. In addition to items related to the VARK questionnaire, socioeconomic status was also asked in the form. The present study was approved by the ethics committee at Başkent University Faculty of Medicine (2007-AP-953-18.12.2007).

2.4. Statistical analysis

Database was transferred to SPSS (Statistical Package for Social Sciences). Statistical analysis of the data was made using SPSS 13.0 version. Chi-square (χ^2) test was used for the analysis of gender and learning variables. Student's *t*-test was used to analyze digit ratio in relation to gender and learning style preference. Data were expressed as "mean ± standard error of mean (SEM)" and percent (%) where appropriate. $p < 0.05$ was considered statistically significant.

3. Results

A total of 183 students (mean age: 20.55 ± 0.20) from a population of 247 (74%) were enrolled in the study. The gender distribution of our participants (females: 60.7%; males: 39.3%) was appropriate with respect to the general population (females: 59.0%; males: 41%). All our students were from families of high socioeconomic status.

Considering the overall distribution of individual learning styles, quadmodal learning (VARK) was found to be the most popular style (24.6%). The percentage of students who preferred unimodal (22.4%) and multimodal (77.6%) learning styles, together with bimodal (19.7%), trimodal (33.3%), and quadmodal (24.6%) subtypes of multimodality are presented in Table 1.

With respect to gender distribution, unimodal learning was more frequent among males (30.6% vs. 17.1%; $p < 0.01$). Multimodal learning rate was 69.4% for males and 82.9% for females. Among multimodal styles, trimodal learning was found to be significantly more frequent in females (39.6% vs. 23.6%; $p < 0.01$). There was no gender based difference in the identification of bimodal (22.2% in males and 18.0% in females), and quadmodal preferences (23.6% in males and 25.2% in females) (Table 1).

Although defined by 1.8% of female students, visual learning preference was not observed among male students. Auditory style was defined by 9.7% of male and 7.2% of female students. Reading/writing preference was identified in 2.8% of males and 1.8% of females. Kinesthetic learning was determined to be more frequent in males (18.1%), when compared to females (6.3%, $p < 0.01$) (Table 1).