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DIGIT RATIO AS AN INDEX OF NUMERICAL AND VERBAL INTELLIGENCE: A STUDY OF ACADEMIC STAFF IN THE HARDCORE SCIENCE AND HUMANITIES IN RIVERS STATE, NIGERIA

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ABSTRACT
Digit ratio is regarded as a physiological marker for the prenatal concentration of the sex hormones; testosterone and oestrogen, which organise the architecture of the body and the brain and the distribution of hormone receptors. This study evaluates the anthropometric values of the 2D:4D as an index of numerical and verbal intelligence. A total of 1093 academic staff drawn from all the tertiary institutions in Rivers State was used for this study. 643(58.83%) were males while 450 (41.17%) were females. The subjects were grouped into two: Hardcore science (A) and Humanities (B), according to their departments. The second to fourth digit length on both hands were measured with a digital venier caliper and the ratio calculated by dividing 2D by 4D. Data was analyzed using SPSS software. Results obtained showed no sexual dimorphism in hardcore science (0.96) and humanities (1.00). A same sex difference was observed in the males across the two groups (A-0.96, B-1.00). The differences were statistically significant ($p<0.001$). There was evidence of brain lateralization indexed by the pattern of digit ratio. There was no hand lateralization. We found an anthropometric difference in terms of 2D:4D between the Hardcore science group and the Humanities group in a typical masculine ratio associated with participants in the Hardcore science group and high ratio associated with the Humanities group. In conclusion, this study clearly showed that digit ratio can be used to classify numerical and verbal intelligence.

KEYWORDS: *Digit ratio, Academic staff and Intelligence.*

INTRODUCTION
Digit ratio is the ratio of different digits or fingers typically measured from the bottom crease where the finger joins the hand to the tip of the finger (Mayhew *et al.*, 2007). In the human hand, the 2nd and 4th digits present a pattern of approximate symmetry around the central axis of the third digit. However there is a considerable variation in the ratio of the length of the 2nd digit to the 4th digit (2D: 4D). Many individuals have longer 2nd digits than 4th and many have longer 4th digits compared to 2nd (Manning *et al.*, 1998). There is abundant evidence suggesting that the former ratio is more common in females and the latter more common in males (Manning, 2002; Phelps, 1952).

Digit ratio is regarded as a physiological marker for the prenatal concentrations of the sex hormones testosterone and oestrogen, which organise the architecture of the body and the brain and the distribution of hormone receptors (Manning *et al.*, 2003).

Digit ratio has been reported to show strong ethnic differences according to Manning (2002), Oladipo *et al.*, (2006), Gwunireama *et al.*, (2010) and influenced by geographical location (Ruston, 1997). Digit ratio has also been reported to be inherited and not necessarily influenced by geographical location (Gwunireama and Ihemelandu, 2010). Common genes, underline development of both fingers and gonads (Kondo *et al.*, 1997 and Peichel, 1997). Many studies debate the existence of sex differences in skills such as visual-spatial and numerical ability, often focusing on the impact of environmental factors. However, biological factors may also be influential; specifically, prenatal androgen exposure may influence brain lateralization and subsequent development of such skills. The ratio between the length of the second and fourth digit (2D:4D, digit ratio) provides a non-invasive measure of prenatal androgen exposure. Males tend to show lower 2D:4D than females, argued to be mediated by in utero concentrations of sex steroids, with 2D:4D negatively related to prenatal testosterone (T) and positively related

to prenatal estradiol (Lutchmaya *et al.*, 2004). Development and organization of the brain is influenced by the same prenatal androgens that determine 2D:4D, with testosterone the most likely candidate to influence cortical dominance. Development of the left hemisphere is thought to be slowed whilst development of the right hemisphere is promoted by the action of testosterone (Geschwind and Galaburda, 1987). Therefore, males, experiencing greater prenatal testosterone exposure, are more likely than females to be right hemisphere dominant and to have lower 2D:4D. Males do excel on tasks reliant on right-hemisphere processing. Consistent male advantages in visual-spatial cognition are reported for adults, particularly on tasks requiring dynamic 3D processing (Geary, 1995), although no consistent advantages are reported in studies of children (Lachance and Mazzocco, 2006). Young boys (4 years) have been found to perform better than girls on a task involving replication of spatiotemporal patterns tapped out on blocks (Grossi *et al.*, 1979). Some studies also report a male advantage on standardised mathematical reasoning tasks (Mau and Lynn, 2000), and on mathematical tasks requiring spatial-mechanical skills or problems that utilize visualisation strategies (Casey *et al.*, 1997). Recently, Jordan *et al.*, 2006 reported that kindergarten boys out-performed girls on tasks assessing 'number sense'. Whilst there is no definitive agreement as to what constitutes number sense, most researchers agree that the abilities to subitize, discern number patterns, compare numerical magnitudes and estimate quantities, count, and perform simple number transformations are key elements of number sense. Others posit a more specific definition of number sense including only non-symbolic and approximate skills that are independent of language (Dehaene, 1997). However, the majority of studies report only trivial or no sex differences, particularly in the early school years, on measures of standardised mathematical achievement (Brosnan, 2006; Brosnan, 2008; and Luxen and Buuk, 2005) or number sense, e.g., counting, number knowledge, or visual number representation (Fink *et al.*, 2006).

Visual-spatial skills and visual-spatial working memory are related to children's early counting (Kyttala *et al.*, 2003), and general mathematics ability measured by standardised achievement and curriculum assessments (Bull *et al.*, 2008; Jarvis and Gathercole, 2003), but few studies have considered biological factors that may result in individual differences in these abilities. Differences in prenatal testosterone exposure may partially account for between- and within-sex differences in these skills via their impact particularly on right-hemisphere development. Significant associations have been reported between mental rotation accuracy and 2D:4D, particularly in men (Manning & Taylor, 2001). Others find a relationship between low 2D:4D and mental rotation ability only in females or find sex differences in testosterone concentrations (measured by 2D:4D, amniotic fluid, or salivary testosterone levels and mental rotation ability, but no relationship between the two (Austin *et al.*, 2002; Putz *et al.*, 2004). Only one study of typically developing children has been conducted revealing that higher prenatal testosterone was associated with better mental rotation performance in girls but poorer performance in boys (Grimshaw *et al.*, 1995).

This study seeks to investigate and document the anthropometric values of the digit ratio of academic staff in the hardcore sciences and humanities in the area under review.

MATERIALS AND METHODS

A total of 1093 Academic staff drawn from the departments of mathematics, computer science, Physics, Chemistry, Architecture, all available fields of Engineering, Law, philosophy, religious studies, English, guidance and counselling, theatre arts from University of Port Harcourt, Rivers State University, Ignatius Ajuru University of Education, Rivers State Polytechnic, College of Education (Tech) all in Rivers State were recruited for this study. 643(58.83%) were males and 450 (41.17%) were females. These subjects gave their informed consent and were willingly recruited for the study. Those having any form of hand deformity were excluded. The subjects were grouped into two: A and B (Brosnan, 2006).

Group A – Hardcore science: Mathematics, Physics, Chemistry, computer science and Engineering departments.

Group B- Humanities: Law, Philosophy, theatre arts, religious and cultural studies, Linguistics and communication studies, English etc.

Second and fourth digit lengths were measured on the ventral (inferior) surface of the hand from the basal crease of the 2nd and 4th digits to the tip using digital venier calliper. The measurements were done twice and average value recorded. The measurements were done on the right and left hands. Values obtained were tabulated. Digit ratio (2D:4D) was then calculated by dividing the length of the second digit by the length of the fourth digit and the values recorded for both hands (Manning *et al.*, 1998). The data was analyzed with Descriptive statistics presented in Mean and standard error. Comparison of differences in mean was tested with Analysis of Variance (ANOVA) using SPSS software.

RESULTS

The results of this study are summarized on two tables below.

Table 1: Comparison of results obtained for Hardcore Sciences and Humanities.

Parameters	Males		Significant difference (p-value)	Females		Significant difference (p-value)
	Hardcore sc. n=390	Humanities n=253		Hardcore sc. n=294	Humanities n=156	
R2D(cm)	7.06±0.58	7.27±0.08	Yes (0.001)	6.69±0.48	7.11±0.47	Yes (0.001)
R4D(cm)	7.34±0.62	7.27±0.62	No (0.161)	6.95±0.48	7.02±0.49	No (0.133)
R2D:4D	0.96±0.04	1.00±0.04	Yes (0.001)	0.96±0.04	1.00±0.04	Yes (0.001)
L2D(cm)	7.13±0.57	7.45±0.72	Yes (0.001)	6.71±0.59	7.13±0.44	Yes (0.001)
L4D(cm)	7.42±0.62	7.37±0.64	No (0.354)	6.98±0.48	7.00±0.05	No (0.155)
L2D:4D	0.96±0.30	1.00±0.06	Yes (0.001)	0.96±0.07	1.00±0.46	Yes (0.001)

All values= Mean ± SE.

Table 2: Comparison of Results obtained for hardcore science and humanities for male and female subjects.

Parameters	Hardcore science		Significant difference p-value	Humanities		Significant difference p-value
	Males n=390	Females n=294		Males n=253	Females n=156	
R2D(cm)	7.06±0.58	6.69±0.48	Yes (0.001)	7.27±0.08	7.11±0.47	Yes (0.003)
R4D(cm)	7.34±0.62	6.95±0.48	Yes (0.001)	7.27±0.62	7.02±0.49	Yes (0.001)
R2D:4D	0.96±0.04	0.96±0.04	No (0.225)	1.00±0.04	1.00±0.04	No (0.212)
L2D(cm)	7.13±0.57	6.71±0.59	Yes (0.001)	7.45±0.72	7.13±0.44	Yes (0.001)
L4D(cm)	7.42±0.62	6.98±0.48	Yes (0.001)	7.37±0.64	7.00±0.05	Yes (0.001)
L2D:4D	0.96±0.30	0.96±0.07	No (0.83)	1.00±0.06	1.00±0.46	No (0.812)

All values = Mean ± S.E.

Table 1 compares the digit ratio of males and females in the two groups. Same sex differences were observed. Males in the hardcore science had digit ratio of 0.96 compared to males in the humanities who had 1.00. This difference was statistically significant ($p < 0.001$). This observation was same for the females. This pattern of digit ratio clearly demonstrates an evidence of brain lateralization.

Table 2 compares the digit ratio of males and females in each group. There was no sexual dimorphism. Males and females of hardcore science had digit ratio of 0.96 whereas in the humanities males and females had digit ratio of 1.00.

DISCUSSION

The second to fourth digit ratio (2D:4D) has been proposed as a putative biomarker for prenatal testosterone and co- varies with the sensitivity of the androgen receptor (AR). Sexual dimorphism was not observed in the humanities as both sexes had a digit ratio of 1.00 on both hands. This result suggests a high level of oestrogen and a low level of testosterone. The import of this is that men in this group had high secretion of oestrogen and hence a digit ratio that is consistent with the female norm of 1.00. This is similar to the report of Purtz *et al.*, 2004 that there is a correlation between verbal fluency and a high digit ratio in males. Males in this group can therefore be said to have high prenatal oestrogen levels. Oestrogen is thought to develop the left hemisphere which is often associated with verbal ability (Luxen and Buunk, 2005). Interestingly these hormones are also thought to contribute in the relative finger lengths of the index and ring fingers (Luxen and Buunk, 2005). The non-sexual dimorphism is similar to the report of Brosnan, 2006. But his values were different and this may be due to geographical differences (Ruston, 1997) who reported that digit ratio is influenced by

geographical location. Manning *et al.*, 2000 had earlier reported that populations closer to the equator have more masculine digits. However, in 2010 Gwunireama and Ihemelandu in their study on the Andonis and Ikwerres in the Niger Delta reported differences in the digit ratio between the two tribes. Their study concluded that digit ratio is inherited and not necessarily influenced by the geographical location.

The result of the present study provides evidence of brain lateralization as shown in the pattern of digit ratio across the different groups. Some ratios were masculine while others were feminine. These results suggest differences in the prenatal concentration of testosterone and oestrogen. This observed evidence of brain lateralization is consistent with earlier studies by Brosnan, 2006; Brosnan, 2008 and Luxen and Buunk, 2005.

CONCLUSION

The present study is one of the few on digit ratio of academic staff population in Nigeria. The findings in this study have revealed that academic staff across hardcore science and humanities have digit ratio that is typical to them: The hardcore sciences (males, 0.96; females, 0.96); humanities (males, 1.00; females, 1.00). This information may be a useful guide in counselling for career choice in line with established values.

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