

## Digit Ratio in Relation to Short-term Memory Among the Three Major Ethnic Groups in Nigeria

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### Abstract

Among other sexually dimorphic traits, second to fourth digit ratio (2D:4D) is said to be higher in males as compared to females. It is confirmed in the uterus, and it's found in unborn, children and it's unaffected by puberty. It is said to be cosmopolitan across ethnic groups, and also exists among other primates. 2D:4D digit ratio has positive correlation with prenatal estrogen but reverse is the case with prenatal testosterone. The present study is focused at investigating the presence of any association between digit ratio (2D:4D) with short-term memory recall skills among the three major ethnic groups in Nigeria. A total of 150 students (75 males and 75 females) participated in the study from Bingham University, Karu, Nasarawa. Relevant data were collected through a self-administered questionnaire which include anthropometric measurement of finger length and memory assessment test (picture free recall, picture placement, word free recall and word placement test). The study found that digit ratio (2D:4D) showed great significant difference in the left hand of both sexes ( $p < 0.01$ ). The memory assessment test showed a very weak correlation with digit ratio (2D:4D), but there was a positive correlation between picture recall, picture placement and word recall skills. Our result also shows no statistical difference among the three major ethnic group. As regard to age, it shows that the earlier the age, the greater the memory recall.

**Keywords:** Digit Ratio; Short-term Memory; Ethnic Group; Anthropometry; Correlation

### Introduction

Lengths of different digits of fingers are measured to assess digit ratio from the midpoint of proximal crease of the palm to the tip of the finger [18]. Fingers and toes begin development at the 6<sup>th</sup> week of conception. Determination of digit ratio is done during embryo development and remain unchanged during subsequent development [20]. The fetus grows quickly during 9<sup>th</sup> week of pregnancy which is the sensitive period of fetal development. Cell differentiation is the main feature in fetal period, and this is sensitive to changes from the external surroundings. During this period, any intra-uterine changes the fetus encounters will not only affect the fetal structures but will also affect the development of the

fingers and toes of the fetus [20]. Different levels of sex hormones exposure in-utero have effect on human fingers [19]. The ring finger is the fourth digit of the human hand while the index finger is the second digit of a human hand [1,10]. It is located between the thumb and the middle finger and usually the most dextrous and sensitive finger of the hand [1]. Exposure to high levels of testosterone results in individuals having ring fingers (fourth digit: 4D) longer than their index fingers (second digit: 2D). While exposure to estrogen has opposite effect; where the index finger seems to be longer than the ring finger. As a result, 2D:4D length is sexually dimorphic where males have lower 2D:4D values than females [19] and it cut across different cultures [22]. Racial differences of 2D:4D

is rarely investigated. Interestingly, 2D:4D differs across nations and differences are grossly larger than the differences in sex found among nations [21]. Voracek and Dressler asserted that these differences are not properly understood, hence encouraging cross-cultural studies to corroborate that assertion [27]. Until recently, samples from different Caucasian ethnic groups were collected and investigated. Manning have demonstrated that 2D:4D ratios differs between ethnic groups [20]. This variation is by far more than the differences between sexes; as noted by Manning [25].

The retrieval of events or information from the past is refer to as Memory Recall. It is among others the main processes of memory. The three types of recall are free recall, cued recall and serial recall. These three forms of recall are used to study the process of memory in humans and animals [3]. In cognitive psychology a recall test is mostly used to measure memory and these tests are used to evaluate different aspect of short term memory which is being able to retrieve recently learned information [13]. The present study is focused at investigating the presence of any association between digit ratio (2D:4D) with short-term memory recall skills among the three major ethnic groups in Nigeria. A total of 150 students (75 males and 75 females) participated in the study from Bingham University, Karu, Nasarawa. The study will add to the existing data of global 2D:4D ratio map, thereby providing valuable information about the three major ethnic groups of Nigeria.

## Materials and Methods

Data for this study was obtained from over 150 students of Bingham university Nasarawa state which consist of the three major ethnic groups. An informed verbal consent was sought from the students who were above eighteen years of age and willing to participate in the survey. In order to encourage more candidate and reliable responses, participants were made to complete a self-administered questionnaire.

The sample size for this study was obtained using the formula:

$$[n = z^2 pq/d^2]$$

Where:

n = The desired sample size

z = The standard normal deviation, usually set at 1.96 (2.0)

p = The proportion in the target population having the particular trait (no estimates 50% is used; i.e. 0.5)

q = 1.0-p

d = degree of accuracy desired, usually set at 0.06

Therefore,  $n = (1.96)^2 (0.5) / (0.06)^2 = 150$ .

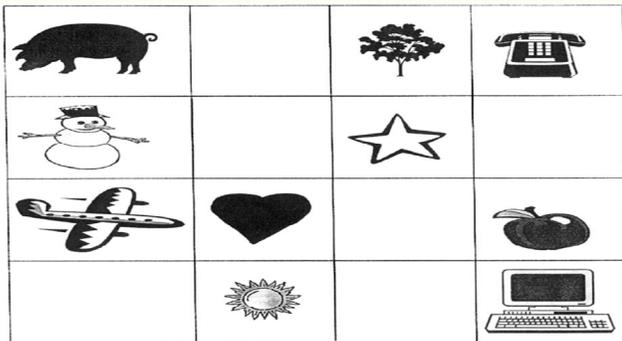
Digit lengths were measured on the ventral surface of the hand from the basal crease of the digits to the tip using a KTC digital Vernier calliper and measuring to the nearest 0.01 mm. The length of the second digit (2D) was divided by the length of the fourth digit (4D) to obtain the digit ratio (2D:4D).

**Figure 1:** Measurement of the digit on the ventral surface of the hand as described by Manning [19].

For the memory assessment, picture recall test, picture placement test, and word free recall test adapted from Jordan were administered. Participants studied a 4x4 grid with 10 power point clip arts of common shapes located in 10 of the squares and they were asked to remember both the object and their locations. For the picture recall and picture placement test, the subjects were asked to view the object for 30seconds and were asked to turn over and write down all they could remember on a blank grid in 1 minutes. And place each words they could remember in the correct location they could remember it. One point was scored for each correct response for a maximum of 10 point per test.

The final test (word free recall) was identical to the picture recall except that the stimulus grid contained 10 common nouns instead of pictures.

Data was expressed as mean  $\pm$  standard deviation (SD). Students' t-test was used to check for the differences in the mean and percentages of sex and tribe and all variables between the three major ethnic groups. Pearson's correlation was used to test the



**Figure 2:** The stimulus grid used in the picture free recall and picture placement recall task.

Home	Water	Park	
	View		Books
Sick		World	
Children		Mother	Relative

**Table a:** The stimulus grid used in the word free recall test.

relationship between 2D:4D and right and left hand, 2D:4D and picture recall, picture placement and word recall test. Linear regression was used to generate predictive equation for the variables. Statistical significance difference was deemed acceptable when  $P < 0.05$ , or  $P > 0.01$ , and the SPSS software was used in the analysis.

**Results**

The study population has a mean ( $\pm$  SD) age of  $19.93 \pm 2.85$  yrs, right digit ratio of (R2D  $6.47 \pm 0.81$ , R4D  $6.86 \pm 0.84$ ) and left digit ratio of (L2D  $6.59 \pm 0.81$ , L4D  $6.92 \pm 0.80$ ) in table 1. Table 2 shows the mean  $\pm$  SD of the picture recall, picture placement, word recall and word placement test and it showed no significant difference in all the four test. There was a significant sex difference with males having lower values than females in both ethnic groups, this difference being stronger for the left hand (right hand; males:  $7.03 \pm 0.24$ ,  $7.44 \pm 0.62$ , females:  $6.02 \pm 0.56$ ,  $6.35 \pm 0.63$ : left hand; males:  $7.20 \pm 0.62$ ,  $7.44 \pm 0.68$ , females:  $6.11 \pm 0.52$ ,  $6.51 \pm 0.63$ ). Table 3 shows the mean and standard deviation of age ( $p > 0.01$ ). Most of the anthropometric variables considered were statistically not significant

except between picture recall, picture placement, word recall and word placement (Table 3). Correlation for 2D:4D (R) and 2D:4D (L) with the memory assessment test among the three major ethnic group shows no statistical significance. From the table 5, left hand 2D:4D were statistically significant with age.

Measurements	Mean $\pm$ SD	Minimum	Maximum
AGE	$19.93 \pm 2.85$	18	39
R2D (mm)	$6.47 \pm 0.81$	5.00	8.50
R4D (mm)	$6.86 \pm 0.84$	5.10	9.00
L2D (mm)	$6.59 \pm 0.81$	5.00	8.30
L4D (mm)	$6.92 \pm 0.80$	5.20	8.70

**Table 1:** Descriptive Statistics of the entire population n = 150.

R2D = Right Second Digit, R4D = Right Fourth Digit, L2D = Left Second Digit, L4D = Left Fourth Digit.  $p < 0.05$ .

Measurements	Sex	Mean $\pm$ SD	T	P
R2D (mm)	Male	$7.03 \pm 0.74$	9.42	0.00
	Female	$6.02 \pm 0.56$		
R4D (mm)	Male	$7.49 \pm 0.62$	10.96	0.00
	Female	$6.35 \pm 0.63$		
L2D (mm)	Male	$7.20 \pm 0.62$	11.01	0.00
	Female	$6.11 \pm 0.57$		
L4D (mm)	Male	$7.44 \pm 0.68$	8.68	0.00
	Female	$6.51 \pm 0.63$		
Picture placement	Male	$5.55 \pm 1.62$	-2.21	0.28
	Female	$6.29 \pm 2.29$		
Picture Recall	Male	$7.05 \pm 1.62$	-2.18	0.30
	Female	$7.64 \pm 1.69$		
Word Recall	Male	$7.38 \pm 1.53$	-0.51	0.60
	Female	$7.54 \pm 2.06$		
Word placement	Male	$5.20 \pm 1.40$	-0.56	0.54
	Female	$5.38 \pm 2.33$		

**Table 2:** Independent sample t test by gender.

R2D = Right Second Digit, R4D = Right Fourth Digit, L2D = Left Second Digit, L4D = Left Fourth Digit.  $p < 0.01$ .

Parameters	IGBO n = 50 Mean ± SD	YORUBA n = 50 Mean ± SD	YORUBA n = 50 Mean ± SD	t	p
Age (yrs.)	19.93± 2.85	18.20± 1.80	18.53± 1.82	12.53	0.001
R2D (mm)	6.69 ± 11.17	6.88 ± 10.03	6.91 ± 0.81	9.42	0.424
R4D (mm)	7.01 ± 1.11	7.20 ± 1.00	7.14 ± 0.82	10.9	0.535
R2D:4D (mm)	0.95 ± 0.04	0.96 ± 0.04	0.97 ± 0.03	0.65	0.211
L2D (mm)	6.77 ± 1.11	6.96 ± 0.99	6.97 ± 0.84	11.01	0.461
L4D (mm)	7.01 ± 1.14	7.14 ± 1.01	7.10 ± 0.84	8.68	0.769
L2D:4D (mm)	0.97 ± 0.04	0.97 ± 0.04	0.98 ± 0.03	0.89	0.097
Picture Recall	48.89 ± 15.73	56.55 ± 16.89	53.22 ± 15.42	-2.21	0.001
Picture Placement	53.18 ± 14.19	66.18 ± 9.89	57.72 ± 13.82	-2.18	0.001
Word Recall	56.16 ± 16.55	71.81 ± 11.80	65.81 ± 16.68	-0.51	0.001
Word Placement	56.89± 16.39	67.64 ± 11.27	63.28 ± 13.51	-0.56	0.001

**Table 3:** Mean and Standard Deviation of Age and Short-term Memory Recall of study participants according to Ethnicity.

R2D = Right Second Digit, R4D = Right Fourth Digit, L2D = Left Second Digit, L4D = Left Fourth Digit. p < 0.01.

	AGE	R2D (mm)	R4D (mm)	L2D (mm)	L4D (mm)	Picture Recall	Picture placement	Word Recall	Word placement
AGE	-	0.203*	0.121	0.251**	0.061	-0.182*	-0.187*	-0.004	-0.035
R2D (mm)		-	0.810**	0.917**	0.798**	-0.148	-0.089	-0.005	-0.078
R4D (mm)			-	0.840**	0.898**	-0.126	-0.045	-0.084	-0.131
L2D (mm)				-	0.755**	-0.171*	-0.097	-0.070	-0.107
L4D (mm)					-	-0.083	-0.044	-0.020	-0.110
Picture Recall							0.552**	0.323**	0.202*
Picture placement								0.287**	0.431**
Word Recall									0.614**
Word placement									

**Table 4:** Correlation of the parameters of the sample population.

R2D = Right Second Digit, R4D = Right Fourth Digit, L2D = Left Second Digit, L4D = Left Fourth Digit. \*p < 0.05, \*\*p < 0.01.

Parameters	Predictive equation	P
R2D (mm)	Age = -0.06 + (-0.01) R2D	0.937
R4D (mm)	Age = -0.14 + (-0.04) R4D	0.841
L2D (mm)	Age = 1.67 + (0.47) L2D	0.039*
L4D (mm)	Age = -0.62 + (-0.15) L4D	0.194
PR	Age = -0.91 + (-0.25) PR	0.905
PP	Age = -0.19 + (-0.13) PP	0.839
WR	Age = 0.12 + (0.08) WR	0.465
WP	Age = 0.07 + (0.04) WP	0.629

**Table 5:** Regression table showing predictive equation in relation with age.

R2D = Right Second Digit, R4D = Right Fourth Digit, L2D = Left Second Digit, L4D = Left Fourth Digit, PR = Picture Recall,

PP = Picture Placement, WR = Word Recall, WP = Word Placement.

\*p < 0.05.

## Discussion

It has been suggested that 2D:4D is negatively related to prenatal testosterone and that the association is particularly strong for the right hand [20]. Digit ratio shows sex differences. Thus, males tend to have lower values of 2D:4D than females and this arises in utero [2]. Therefore, the ratio between the length of the second and fourth digits (2D:4D) is a trait that is sexually dimorphic, males have lower 2D:4D values than females [7] and it is a cross-cultural trait [8,21]. In addition, there are some evidence that 2D:4D also correlates with indices of sexually dimorphic traits of human body. These relationships were found to be stronger for females than for males among the three ethnic groups. 2D:4D is supposedly related to prenatal hormonal levels [22,25] the present data suggest an early organizational effect of sex hormones at least for females, through the association between indices of body shape and finger length patterns.

The results of this study are consistent to some extent with the sexual dimorphism of physical traits and cognitive styles developed under the influence of sex hormones at puberty which is cross-cultural. Male and female body shape is influenced by sex-steroids ratios. Whereas organizational effects are supposed to change an organism early in life, basically influencing its structure as well as its brain, these activational effects are apparent later in life and influence the way previously established structures function. If the

assertion of an organizational and activational effect of hormones were true, it is supposing that evidence will accumulate that this finds its expression also in finger length patterns.

Exposure to testosterone in-utero may directly influence intelligence, by changing neuronal migration, resulting in development of the right hemisphere [8], as well as higher coordination within and between the hemisphere [9]. This could result in neuronal networks becoming dense in areas related to cognition, learning and memory, either by reducing brain cells apoptosis during development, or heightening migration of cells to those areas [12,17]. Therefore, significant relationship between the 2D:4D ratio and performance on basic numerical task can be noticed.

In the study, digit ratio (2D:4D) showed great significant difference in the left hand of both sexes. Several studies conducted has shown that women tend to have higher recall than men [18] and this is due to the fact that hormones affecting 2D:4D also directly or indirectly affect recall skills in females with the reproductively low androgen and higher estrogen level producing more feminine hands and better recall abilities [11,19]. Hence, men with high digit ratio are expected to have good visual recall skills while women with lower digit ratio have low recall skills.

The result shows no statistical difference among the major ethnic groups considered, but still revealed that Hausa and Igbo ethnic group has the lowest ratio of 2D:4D in both sexes, while the Yoruba have the highest ratio that is female typical 2D:4D ratio in both sexes. This support the study of Manning and colleagues who reported that digit ratio varies greatly between different ethnic groups, and the variation is far larger than the difference between sexes [20,22]. 2D:4D is highly significant in similar population [14,15]. Low mean ratio has been found in a black population and similar "masculinized" have been reported in Afro-Caribbean's sample from Jamaica. In line with most studies our research shows that the finding of sex differences in 2D:4D is consistent with previous research [27,28], there were marked statistical differences in the comparison between male and female right hand, which agrees with most studies that says right hand [16,17]. On the contrary, left handed male and female showed no statistical difference on most anthropometric variables.

Finally, the study also looked at the age among the three major ethnic groups in which digit ratio and memory assessment test

were statistically not significant except for the left hand 2D which showed a great significance. Therefore, from this research, it shows that the earlier the age, the greater the memory recall.

## Conclusion

The result of this study corroborates the ratio of 2<sup>nd</sup> to 4<sup>th</sup> digit length (2D:4D) as been sexually dimorphic with males having lower digit ratio than females. This holds true for the three major ethnic groups. It also shows that negative relationship exists between the right, left digit ratio among the three major ethnic group but stronger for the right hand and it is a cross-racial trait. Weak relationship exists between ethnic group and memory recall skills. Strong relationship also exists between age, digit ratio and the memory recall skills.

## Bibliography

1. Arthur RM., *et al.* "Improved estimation of pericardial potentials from body surface maps using individualised torso models". *Journal of Electrocardiography* 31 (1998): 106-113.
2. Auyeung B., *et al.* "Fetal testosterone predicts sexually differentiated childhood behaviour in girls and in boys". *Psychological Science* 20 (2009): 144-148.
3. Baker F. "Anthropological notes on the human hand". *American Anthropologist Personality of Individual Difference* 1 (1888): 51-76.
4. Bardin CW and Caterall CF. "Testosterone: a major determinant of extragenital sexual dimorphism". *Science* 211 (1981): 1285-1294.
5. Churchhill AJG., *et al.* "The effects of sex, ethnicity, and sexual orientation on self measured digit ratio (2D:4D)". *Archive of Sexual Behavior* 36.2 (2007): 251-260.
6. Cabeza, R., *et al.* "Functional neuroanatomy of recall and recognition: APET study of episodic Memory". *Journal of Cognitive Neuroscience* 9.2 (1997): 254-265.
7. Craik FI., *et al.* "Divided Attention During Encoding and Retrieval: Differential Control Effect?" *Journal of Experimental Psychology: Learning, Memory, and Cognition* 26.6 (2000): 1744-1749.
8. Danborno B., *et al.* "Relationship between Digit Ratio (2D:4D) and Birth Weight in Nigerians". *Anthropologist* 12.2 (2010): 127-130.
9. Danborno B., *et al.* "Sexual Dimorphism and Relationship between Chest, Hip and Waist Circumference with 2D, 4D and 2D:4D in Nigerians". *The International Journal of Biological Anthropology* 1.2 (2007).
10. Fink B., *et al.* "The 2nd-4th digit ratio (2D:4D) and neck circumference: implications for risk factors in coronary heart disease". *International Journal of Obesity* 30 (2006): 711-714.
11. Hönekopp J., *et al.* "Second to fourth digit length ratio (2D:4D) and adult sex hormone levels: New data and a meta - analytic review". *Psych Neuroendocrinology* 32 (2007): 313-321.
12. Hönekopp J., *et al.* "Digit ratio (2D:4D) and physical fitness in males and females: Evidence for effects of prenatal androgens on sexually selected traits". *Hormones and Behaviour* 49 (2006): 545-549.
13. Hall., *et al.* "Serial recall of rhythms and verbal sequences: Impacts of concurrent tasks and irrelevant sound". *Quarterly Journal Experimental Psychology* 1 (2011).
14. Ibegbu AO., *et al.* "Anthropometric Study of the Index (2<sup>nd</sup>) and Ring (4<sup>th</sup>) Digits in Epira Ethnic Group of Nigeria". *Asian Journal of Medical Sciences* 4.2 (2012): 79-84.
15. Son LK. "Spacing one's study: Evidence for a metacognitive control strategy". *Journal of Experimental Psychology: Learning, Memory and Cognition* 30.3 (2004): 601-605.
16. Lundqvist T. "Cognitive consequences of cannabis use: Comparison with abuse to stimulants and heroin with regard to attention, memory and executive functions". *Pharmacology Biochemistry and Behavior* 81.2 (2005): 319-330.
17. Lutchmaya S., *et al.* "2<sup>nd</sup> to 4<sup>th</sup> digit ratios, fetal testosterone and estradiol". *Early Human Development* 77 (2004): 23-28.
18. Malas MA., *et al.* "Fetal development of the hand, digits and digit ratio (2D:4D)". *Early Human Development* 82 (2006): 469-475.
19. Manning JT., *et al.* "The ratio of 2<sup>nd</sup> to 4<sup>th</sup> length: a predictor of sperm numbers and concentrations of testosterone, luteinizing hormone and estrogen". *Human Reproduction* 13.11 (1998): 3000-3004.
20. Manning JT., *et al.* "Sex and ethnic differences in 2<sup>nd</sup> to 4<sup>th</sup> digit ratio of children". *Early Human Development* 80.2 (2004): 161-162.

21. Manning's JT, *et al.* "The 2<sup>nd</sup>: 4<sup>th</sup> digit ratio, sexual dimorphism, population differences, and reproductive success. Evidence for sexually antagonistic genes?". *Evolution and Human Behaviour* 21.3 (2000): 163-183.
22. Manning JT, *et al.* "Second to fourth digit ratio: ethnic differences and family size in English, Indian and South African populations". *Annals of Human Biology* 30 (2003): 579-588.
23. Schwerdt FA and Heer J. "Second to fourth digit ratio (2D:4D) of the right hand is associated with nociception and augmenting-reducing". *Personality and Individual Differences* 45 (2008): 493-497.
24. Sluming VA and Manning J T. "Second to fourth digit ratio in elite musicians: evidence for musical ability as an honest signal of male fitness". *Evolution and Human Behaviour* 21 (2000): 1-9.
25. Tulving E., *et al.* "Neuroanatomical correlates of retrieval in episodic memory: Auditory sentence recognition". *Proceedings of the National Academy of Sciences, USA* 91 (1994): 2012-2015.
26. Tulving E and Thomson M. "Encoding specificity and retrieval processes in episodic memory". *Psychological Review* 80.5 (1973): 352-373.
27. Voracek M., *et al.* "Digit ratio (2d:4d), lateral preferences, and performance in fencing". *Perceptual and Motor Skills* 103 (2006): 427-446.
28. Yang H., *et al.* "Her Voice Lingers on and Her Memory Is Strategic: Effects of Gender on Directed Forgetting". *Plos ONE* 8.5 (2013): 1-9.
29. Yarmey D. "Adult, age and gender differences in eyewitness recall in field settings". *Journal of Applied Social Psychology* 23.23 (1991): 1921-1932.

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