

2nd to 4th digit ratios and handedness in UM BMS1 students

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Introduction

Right-handed people comprise between the 80% and 90% of the Anglo-Saxon population, as has been studied via the use of questionnaires, without any significant variation in this metric between genders (1). Handedness seems to appear early on in a person's life, with the first indications of their handedness bias recently in the post-natal period. One example of such behaviour is newborns preferring to lie with their head turned to a specific side after being held in a midline position, which was strongly related to the hand which most frequently contacted the mouth (2). This, along with other evidence, suggests that handedness is mediated by an epigenetic marker. Handedness can be measured in two ways: hand preference or hand performance. Hand preference is determined by getting people to describe which hand they use when performing single-hand tasks (IE: writing or drawing). Hand performance is measured by having them perform specific tasks (IE: placing pegs in small holes as rapidly as possible), measuring and comparing the time that the task took (3). This study only looked at self-reported hand preference.

Some evidence seems to point towards the ratio of prenatal testosterone to prenatal oestrogen as being an important factor in the development of extragenital sexual dimorphisms, of which the differentiation of the nervous system is a part of. Said differentiation may include the expression of laterality preferences. This is hypothesized to be due to testosterone slowing down growth within some areas of the left hemisphere, while promoting growth of certain others in the right hemisphere (4). Another extragenital sexual dimorphism related to prenatal testosterone levels has been observed to be the 2nd to 4th digit ratios, with a negative correlation between it and the fetal testosterone to fetal oestradiol ratio (5). The 2D:4D theory has caused controversy in the scientific community due to producing irreproducible or contradictory results, as well as an exaggeration of its usefulness and applications in medicine. The psychologist Martin Voracek has compared the study of this ratio to phrenology (6). Its relationship with handedness is also under a fair amount of criticism, as there are two main neurological development models that seem to contradict each other (the Geschwind-Behan-Galaburda model and the sexual differentiation model (high prenatal androgen levels are associated with left-handedness) predict the opposite of the callosal hypothesis (high prenatal androgen levels are associated with right-handedness in males)) (7). The purpose of this work was to examine the association between the 2D-4D ratio and handedness.

Materials and methods

Only first-year biomedical students were recruited to participate in this study. There were no exclusion criteria, and participation was voluntary, though highly encouraged. The subjects

were instructed, during an informative session in which the project was discussed and explained, how to properly measure their own finger lengths. These measures had to be taken with a ruler, from the middle of the bottom-most crease to the tip of each of the studied fingers, and they had to be written down in the provided data collection spreadsheet in millimetres. The 2D:4D ratio of each hand had to be calculated and registered in the spreadsheet.

The data was collected anonymously via each student's project mentor, compiled into a single common database, and shared for analysis. Alongside 2D and 4D lengths of both hands, participants were also asked to note down their age and handedness. The influence of gender in handedness or digit ratio was not of interest in this study.

After the data collection, a descriptive statistical analysis and data graphing were performed using IBM SPSS.

Results

The results of a descriptive statistical analysis showed that left-handed people (*Table 1*) had, in average, a higher 2D:4D ratio than right-handed people (*Table 2*). Left-handed people also were shown to have a higher ratio when compared to the mean from all the studied subjects (*Table 3*). The standard deviation was very similar in both groups when compared between each other or against the general population.

Table 1: Descriptive statistical analysis of the results from left-handed subjects

	L Hand	R Hand
Subjects	19	19
Mean	1,005	0,988
Median	1,013	0,986
Standard Deviation	0,044	0,055

Table 2: Descriptive statistical analysis of the results from right-handed subjects

	L Hand	R Hand
Subjects	138	138
Mean	0,982	0,985
Median	0,974	0,974
Standard Deviation	0,045	0,043

Table 3: Descriptive statistical analysis of the results from all subjects

	L Hand	R Hand
Subjects	157	157
Mean	0,985	0,985
Median	0,985	0,974
Standard Deviation	0,045	0,045

Three outlying values were observed when observing the average 2D:4D ratio in each subject (*Figure 1*). It can also be seen that these outliers were only found in right-handed subjects (*Figure 2*). It can also be observed that, while both the group of participants that showed left handedness, and the group that showed right handedness both have a similar range of average 2D:4D ratios, the distribution is skewed towards a higher ratio in the left-handed participants, compared to no appreciable bias in right-handed participants.

It was also noted that left-handed participants in the study comprised a 12,1% (19/157) of the sample, compared to a 87,9% (138/157) of right-handed participants.

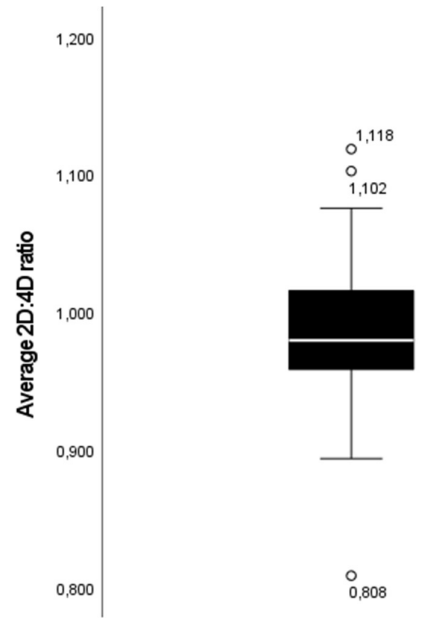


Figure 1: Box-and-whiskers graph of the 2D:4D ratios of all participants

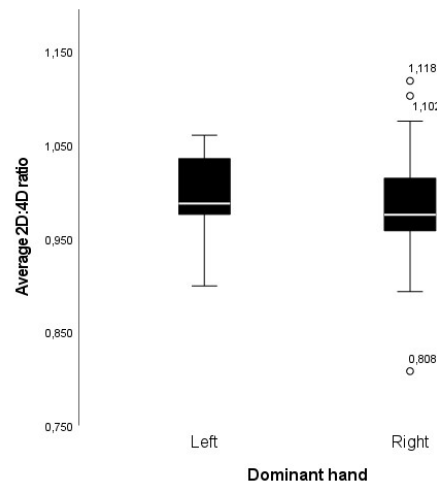


Figure 2: Box-and-whiskers graphs of the 2D:4D ratios of subjects, discriminated by handedness

Discussion

Left-handed participants were found to have, in average, a higher mean 2D:4D ratio. Both groups showed a similar standard deviation in the mean 2D:4D ratio which, in conjunction with the mean being higher in left-handed subjects suggests that, in the general population, this correlation between left-handedness and a higher-than-average 2D:4D ratio would still apply. This correlation may also point towards handedness being correlated to the fetal testosterone to fetal oestrogen ratio, though it is not a conclusive result, due to the 2D:4D ratio being a highly controversial topic amongst researchers (6). These results seem to align with

preexisting literature. A meta-study from late 2020 suggests that left-handedness is associated with a lower R2D:4D ratio and a higher L2D:4D, though the difference between the average value and the ones studied in the paper was found to be “very small in magnitude”, and the authors concluded that the differences in 2D:4D ratio may be better explained by “subtle changes to 2D and/or 4D of the writing hand that come about as a consequence of gripping a pen or pencil” (7).

The sample used in this study seems to be representative of the larger population, as handedness is estimated to be between 85 and 90% for right-handed people and 10-15% for left-handed people (3), and our sample could be situated in the middle of this range; though the sample size was not large enough as to be able to draw significant conclusions.

Another weakness of this study was that the subjects measured their own finger lengths and 2D:4D ratio, which may have caused the data to be measured in a slightly different way between subjects.

References

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