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Digit ratios, Baron-Cohen's Reading the Minds in the Eyes and dart-throwing task

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DIGIT RATIOS, BARON-COHEN'S READING THE MINDS IN THE EYES AND DART-THROWING TASK

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Abstract

There is evidence that high prenatal testosterone and the ratio of the index finger to the ring finger are correlated. There is also evidence that male-typical finger ratios correlate positively with male-typical tasks such as targeting and negatively correlated with female-typical tasks. This study examines the correlation between the digit ratio and the dart throwing task and also the digit ratio and Baron-Cohen's Reading the Mind in the Eyes test. A different digit ratio, the ratio of the index finger and the ring finger to the pinky is also collected and correlated with both of the other tests. Sometime during the study, a pattern of length change across the two hands was also observed and this was also correlated. The only significant result observed is that men perform, on average (x=7.101 cm, SD=2.0183), better than women did (x=9.338 cm, SD=2.2869).

Introduction

The idea that hormones influence behavior and cognition is widely accepted. Two hormones especially come to mind: estrogen and testosterone. There are multiple ways these two hormones can affect behavior and cognition. However, the prenatal influence of these two hormones is presently the most relevant. It is difficult to study prenatal hormones for ethical reasons. Therefore, external markers of prenatal hormone exposure are useful research tools. The classic measure of prenatal testosterone is the ratio of the index finger to the ring finger. This study proposes a different measure, the ratios of the index finger and the ring finger individually to the pinky.

Literature Review

The 2D:4D ratio is a useful external marker of prenatal testosterone levels. The purpose of this study is to correlate this ratio with Reading the Mind in the Eyes test and a dart throwing task. The purpose is also to introduce new external measures of prenatal testosterone.

Lutchmaya, Baron-Cohen, Raggatt, Knickmeyer and Manning (2004) note that larger index finger (2D) to ring finger (4D) ratios are more typical of women and lower 2D:4D ratios are more typical of men. They studied the correlation between the 2D:4D ratio and prenatal testosterone and estrogen levels in 33 children. The fetal hormones were measured during the second trimester of pregnancy through routine amniocentesis. The digit ratio was taken when the children were two years old. The findings came out positive. The digit ratio is negatively correlated with the ratio of fetal testosterone to fetal estrogen. They also examined each hormone individually. It was found that high digit ratios occurred with low fetal testosterone and high fetal estrogen. This finding supports the idea that 2D:4D can be used to measure prenatal relative amounts of testosterone and estrogen.

Contrary to this, Hickey et al. (2010) were unable to find a sufficiently significant correlation between 2D:4D and prenatal testosterone. They studied other hormones besides testosterone. However, those hormones are irrelevant presently. 244 girls were studied. Prenatal levels of testosterone—as well as other hormones—were taken at 18 weeks of gestation and also at the 34th week of gestation. The digit ratio was taken later between 14 to 16 years of age. No relationship was found with testosterone and digit ratio.

However, other studies still advocate the use of the digit ratio. Brown, Hines, Fane and Breedloves (2002) studied males and females with and without congenital adrenal hyperplasia (CAH). CAH is a condition in which a hormone regulating the production of testosterone is not produced and leads to the release of excessive amounts of testosterone. Thus, females with CAH are girls exposed to almost male amounts of testosterone. Therefore, if CAH females present male-like digit ratios, that would support the use of the digit ratio to identify relative amounts of testosterone and estrogen exposure before birth. They observed the digit ratio in 13 women with CAH, 16 men with CAH, 44 non-CAH women and 28 non-CAH men (Brown et. al., 2002). They found that males with CAH presented the most masculine hands, meaning that they had the lowest digit ratio. Women without CAH had the most feminine hands. Interestingly, women with CAH presented more masculine hands than men without CAH, and this result in particular is consistent with the idea that the digit ratio can be used to indicate relative exposure to prenatal testosterone.

However, the precise method of measuring the digit ratio is important as well. It is found that photocopying the hand and then measuring the digits tends to be associated with a lower digit ratio (Manning, 2005). The same study also found that the differences between digit ratios

were better observed when photocopies were taken. As this is unavailable presently, a direct measurement is preferred.

With this correlation established, the digit ratio has also been compared with performance on spatial abilities, which are reputed to be male favoring. Thus, people with more masculine hands should perform more male-like in tests of spatial abilities. Using a sample of 40 women with CAH, 29 women without CAH, 29 men with CAH and 30 men without CAH, the digit ratio was compared to two different mental rotation tasks and two different targeting tasks—both targeting and mental rotation tasks are markers of spatial ability (Hines, 2003). On both of the mental rotation tasks, men performed better than women, the two groups of women performed equally as well and men without CAH performed better than men with CAH. This indicates that there is a point after which testosterone exposure hinders performance on the mental rotation task. It is interesting that both of the female groups should perform equally as well, that there was not an improvement in women with CAH. Almost the complete opposite was true for the targeting tasks. On both of the targeting tasks, men in general performed better than women (Hines, 2003). However, men with CAH performed equally with men without CAH. Women with CAH performed better than women without CAH. The improvement in women was consistent with the idea that people with a more masculine digit ratio would perform male-like in male favoring tasks. However, the identical performance of the two groups of men is unexpected.

Another study examined the correlation between the digit ratio and performance on the mental rotation task (Peters, Manning, & Reimers, 2007). They also examined sexual orientation, but that is currently irrelevant. Basically, a sample of 134,317 men and 120,783 women was taken and their performance on the mental rotation task was measured and their digit ratio was

calculated. A clear negative correlation between the digit ratio and mental rotation task was found. Therefore, those with more masculine hands (lower 2D:4D) performed better on the mental rotation task.

Falter, Arroyo and Davis (2006) also studied the association between spatial abilities and digit ratios. Their findings are more consistent with Hines et al.'s findings (2003). They found that only sex predicted performance on the mental rotation task, with men performing better than women. They also found that the digit ratio is correlated with performance on a targeting task.

In addition to a spatial test, non-spatial tests are also of interest. There is some evidence of a shift in the way the brain has lateralized during development, with the male brain lateralization shift to the right (Baron-Cohen, Lutchmaya & Knickmeyer, 2004). The non-spatial task chosen is Baron-Cohen's Reading the Mind in the Eyes test (RME). This is a test of a person's ability to identify the expressed emotion when presented with only the picture of the eyes and has been used previously (Voracek & Dressler, 2006; Cook & Saucier, 2010; Chapman et. al., 2006). When comparing RME with fetal testosterone measured during pregnancy, Chapman et al. (2006) found a negative correlation between the number of correct responses to the RME and fetal testosterone. Voracek and Dressler (2006), however, did not find a significant relationship between RME scores and prenatal testosterone as predicted by 2D:4D. Cook and Saucier (2010) found a significant relationship between MRE scores and the mental rotation test but was not able to find significance with the targeting test.

Although both the mental rotation task and the targeting task are good measures of spatial ability, the targeting task is preferred presently. This is because Peters et al. (2007) have already established a strong correlation between the mental rotation task and the digit ratio and they have a sample size superior to any available at the present. Instead the targeting task is used.

The targeting task utilized dart throwing, which was one of the two methods Hines et al. (2003) used to measure targeting and found significance. After the darts are thrown, the distance from the bulls-eye was recorded, so bigger scores on this test reflected poorer performance. It was hypothesized that larger numbers on the dart-throwing task would occur with higher 2D:4D ratios. The online version of Baron-Cohen's Reading the Mind in the Eyes (Rowe) test was printed out and administered. The element of interest in this task was the number of incorrect responses to the 36-item questionnaire. Because larger numbers reflected poorer performance, a negative correlation between 2D:4D and Reading the Mind in the Eyes task (RME) was expected.

The classic digit ratio, 2D:4D, was measured manually, using a ruler down the midline of the index finger and the ring finger on both finger. Two different numbers were obtained, one for the right hand and one for the left hand., Because prenatal testosterone lengthens the ring finger and prenatal estrogen lengthens the index finger (Manning, 2002), it was also hypothesized that individual, weighted lengths of the finger would correlate differently with the male-typical and female-typical tasks. The individual lengths were weighted by the length of the pinky (5D). Because of the lack of data, the pinky was chosen by flipping a quarter, and by chance, was preferred over the middle finger. In hypothesis, a larger 4D:5D ratio reflects higher prenatal testosterone and therefore would negatively correlate with the moment from the bull's eye in the dart-throwing task. A larger 2D:5D reflects higher prenatal estrogen and would correlate negatively with errors on the RME.

This data was entered into SPSS and the one-way ANOVA, independent groups t-test and bivariate correlations were used. The specific null hypotheses that needed to be rejected are the following: there are no differences between men and women in terms of 2D:4D, 2D:5D, 4D:5D

on both hands; men and women do not perform differently on the RME test and they do not perform differently on the dart-throwing task. The actual research hypotheses are the following: That women have a larger 2D:4D and 2D:5D, and men have a higher 4D:5D. It is also expected that women will make less mistakes than men on the RME and will differ from the bulls-eye more greatly than men.

Method

Participants

A recruitment ad was posted in the Maucker Union, a special invitation was sent to University Honor's students, and the PSPM system was used to recruit introductory to psychology students. 31 students (9 men and 22 women) responded. 17 participants, including 8 of the men were recruited from the PSPM system. 14 participants were recruited from the Honor's student invitation and the Maucker Union ad combined. Although two ages were not recorded, the men were slightly younger than women. On average, men were 19.88 (SD=1.126) years old and women were 20.14 (SD=1.711) years old. The total range was between 18 and 26 years of age.

Procedure

Upon arrival to the study location, the participant was asked to sign the consent form (Form2). Form 2 was then used for each subject for all the aspects of the data collection. A chronological subject number was given. The first participant was numbered 11 and the last was numbered 41. The finger measurements were taken first, then the RME was administered. The darts were thrown at the end of the session.

Digit Ratio

With a metric ruler, the participant's index (2D), ring (4D) and pinky (5D) fingers were measured in millimeters on both hands. The fingers are measured palm up with the ruler's zero marker positioned in the bottom of the crease at the base of the finger. The ruler is held so that it is roughly at the midline of the finger. The measurement does not include the nail. The ruler is held parallel to the table using a 7.5cm x 2.5cm x 1.4 cm block and the measurements were taken when read when leaning directly over the finger. The lengths of the fingers are divided by each other. The classic ration (2D:4D) is computed as well as the newer ratios (2D:5D and 4D:5D). These values are recorded in Table1. The averages are depicted separately in Table2.

Reading the Mind in the Eyes Test

This is a test developed by Baron-Cohen and is available online. It is a computer based test. It consists of 36 pairs of eyes, and four emotion options for each pair (Rowe). The participant selects one of the four suggested emotions that best describes the expression in the eyes.

Presently, this test was printed off and was given to the subjects in a paper and pen fashion. Later, during analysis, it was suspected that the scores on the RME test were confounded. As the study progressed, more paper copies of the test were made and the pictures got progressively darker and harder to judge. This was not done on purpose. The number of incorrect guesses is recorded for each participant in Table3.

Targeting Task

A dart throwing task was used to measure targeting as the spatial skill. Dart throwing was one of the two targeting tasks used by Hines et al. (2003) and has produced significant results previously. A commercial, self healing dart board with a radius of 22.8 cm was used. The actual bulls-eye was a red circle with a centimeter diameter. This target was placed in a 50 cm x 50 cm

wooden frame. This was mounted on a 1.055 m tall shelf and slightly titled to keep it from falling. The subjects aligned themselves directly in front of the bulls-eye and stood 2.24 m away.

The participant was given three trial attempts to adapt to the darts and the task. Following that, the participant threw five numbered darts in order. The average distance from the boundaries of the bulls-eye is taken and recorded in Table4.

Results

Digit Ratios

In an independent samples t-test on SPSS, it was found that the 2D:4D ratio of both hands did not significantly differ between men and women. Males had a mean of 0.98646 (SD=.033578) on the left hand and 0.95788 (SD=.0884) on the right hand. Females had a mean of 0.97288 (SD=.03837) on the left hand and 0.96611 (SD=.050008) on the right hand. Neither of the differences was significant. The p for the left hand was 0.341 when equal variances was not assumed and was 0.798 on the right hand when equal variances were not assumed.

The other ratios, 2D:5D and 4D:5D, on both hands was also put into the independent samples t-test. The ratios are not significantly different between men and women. They also do not correlate significantly with the other tests. The correlation with other variable is depicted in Table5**.**

Reading the Mind in the Eyes Test

In an independent samples t-test, a significant difference was not found. Men missed an average 13.89 (SD=3.855) on the RME and women missed an average of 11.59 (SD=3.554) on the RME test. The p was 0.121 when the equality of variances was assumed and 0.146 when the equality of variances was not assumed. The range was between 4 and 19.

When the number of times an emotion was missed is weighed according to the relative number of men and women, more women misjudged the emotions than men did except for three. Women were more likely to correctly identify "worried", "fantasizing" and "serious" than men.

The confounding effect of the printing was statistically analyzed as well. Because the subject numbers were given in chronological order, performance on the RME test was correlated

with the subject number. The Pearson correlation was -0.118 and p was 0.528. There seems to be a slight correlation, but it is insignificant.

Dart-Throwing Task

In an independent samples t-test on SPSS showed that the average difference from the bulls-eye of males was 7.101 cm (SD=2.0183) and of women was 9.338 cm (SD=2.2869). The differences between the men and the women were significant with p=0.016.

Table6 has the correlation of all the variable to each other.

In addition, in two subjects, a trial of dart throwing was excluded. One person threw the dart too far off the bulls-eye and at the wall where it did not leave a mark. In the other case, the dart fell before it could be measured but the subject had already left.

Discussion

Surprisingly, men and women did not have digit ratios that were distinct enough to be significant. The three ratios (2D:4D, 2D:5D, 4D:5D) on either hand did not differ enough to be significant. Of most interest are the two 2D:4D ratios. Males had a mean of 0.98646 (SD=.033578) on the left hand and 0.95788 (SD=.0884) on the right hand. Females had a mean of 0.97288 (SD=.03837) on the left hand and 0.96611 (SD=.050008) on the right hand. The p for both was less than 0.05. However, even if significance is not taken into account, the men appear to have a greater 2D:4D than women on the left hand which was not expected and is contrary to previous literature (see Brown et al, 2002).

This leads to the failure to reject the null hypothesis that men and women have equal digit ratios. However, the use of direct measurement of the fingers was previously called into question (Manning, 2005). Perhaps if a scanner had been used rather than simply measuring with a ruler, a better ratio could have been found. Furthermore, the fingers were measured from the bottom of

the crease, not at the center, which is different from all previous studies. This could confuse the results.

It is also highly surprising that relative to their number, men should miss individual questions on the RME than women do. However, it must be noted that in general, men performed worse than women though not at a statistically significant level. This is shown in the fact that the men's mean was 13.89 (SD=3.855) while the women's mean was 11.59 (SD=3.554). The significance was at the 0.121, making this result insignificant. Although the null hypothesis stated that men and women perform equally on the RME cannot be rejected, the difference is still present. Furthermore, why women would more accurately identify "fantasizing," "worried" or "serious" is a good question.

The insignificant correlation between subject number and the score on the RME (p=0.528) indicates that the darker shading in the later copies of the RME test did not significantly confound the data. This could indicate that even at times when there is inadequate lighting, a person is not less able to correctly judge emotions.

The dart-throwing task presented the only significant relationship. Men averaged 7.101 cm (SD=2.0183) from the bulls-eye while the women averaged 9.338 cm (SD=2.2869). This difference was significant at the p=0.016 level. However, men's improved coordination could have affected this difference because this was an overhand test. It may have ended up being a measure of motor ability rather than targeting ability. However, this leads to the rejection of the null hypothesis that men's ability to hit the bulls-eye in a dart throwing task is equal to that of a woman's.

Although there was some correlation between the digit ratios, it is disappointing that none of the ratios correlated with the RME score or the targeting score. Improving the technique of

measuring fingers could help solve this problem. Additionally, if the group size was greater than 31, perhaps at 100 or larger, the relation between the digit ratios and the other tasks may have been observed. However, although this was not hypothesized, it was observed that the right hand 2D:5D ratio correlates positively with the right hand 2D:4D ratio ($r=0.657$, $p=0$) and negatively with the right hand 4D:5D ($r=-0.509$, $p=0.003$). Mathematically, this makes sense, but it could also indicates a use for alternative digit ratios as markers of prenatal hormone exposure.

The alternate ratios involving 5D also had insignificant relationships with the other variables. It could be that 5D itself has a currently unknown variable affecting it and might not have been valid. Perhaps if a different nuetral finger was used to isolate the ratio of 2D:4D, then a better individual effect of both 2D and 4D separately could have been observed.

Measuring 2D:4D directly was a serious limitation of this study and calls for repetition in the future. The use of a dart throwing task could also favor male performance; an underhand technique, as in Hines et. al.(2003), could reveal better relationships between the classic digit ratio, alternative 5D ratios and spatial tasks. However, the small sample size is the most important limitation. This study must be repeated using a larger sample size, with more precise measurements.

Ethical Considerations

This study does not involve any form of deceit. The participants are allowed to leave the study at any time. There are no anticipated costs to the study unless a participants uses the darts to harm others.

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Form1 The consent sheet

This study is being conducted as part of an Honor's Student Thesis part of the University of Northern Iowa Honors Program.

The purpose of this study is to examine the relationship between a spatial test, an emotion reading task and a marker of prenatal development. As part of this study, both of your ring fingers and both of your index fingers will be measured. You will be asked to throw darts and you will be asked to judge the emotion in pictures of thirty-six different pairs of eyes. The study will take about half an hour. The study is carried out in Baker Hall, Room 443.

Your participation is entirely voluntary and you may withdraw from this study at anytime. The risks associated with this study are no greater than day-to-day life. There will be no compensations in the event of harm. There are also no personal benefits to this study, however, the outcome of the study could benefit the scientific community. If you decide to participate, you will be given a number so your information will be completely confidential. If you decide against continuing during the study, any information collected from you will be confiscated.

I am Betul Zora, and I am an Honor's student completing my Honor's Thesis. My faculty advisor is Linda Walsh, in the College of Social and Behavioral Sciences. If you have any questions you can email me at zorab@uni.edu.

As a participant, if you feel your rights have been violated or have any other questions regarding your rights, you may contact Anita Gordon (319-273-6148, anita.gordon@uni.edu), the University of Northern Iowa IRB Administrator. An unsigned copy of this consent sheet will be given so that you will have a copy of all of the contact information.

In signing this sheet I acknowledge the following:

I consent to participating in this study and allow Betul Zora to collect data from me

I know that I will be throwing dart and promise not to throw the darts to cause harm

I allow Betul Zora to measure my fingers

I will be identifying emotions in the eyes

I agree with the above and have no objections to participating

Participant

Name (print)

Signature

Date

Investigator

Name (Print) **Betul Zora**

Signature

Date

Form2

Suject number **Date**

Gender M F

Dart Throwing (cm)

First throw:

Second throw:

Third throw:

Fourth throw:

Fifth throw:

Average

Digit ratio (cm)

2D on left hand:

4D on left hand:

2D:4D on left hand:

2D on right hand:

4D on right hand:

2D:4D on right hand:

2D:4D average:

Reading the Mind in the Eyes test

Number incorrect:

Table 1 Digit ratios of the subjects

Number	Gender	L2D:5D	L4D:5D	L2D:4D	R2D:5D	R4D:5D	R2D:4D
11	1	1.12121	1.13636	0.98667	1.10769	1.27692	0.86747
18	1	1.2	1.23333	0.97297	1.16949	1.22034	0.95833
19	1	1.24138	1.28448	0.96644	1.22222	1.23077	0.99306
20	1	1.24561	1.22807	1.01429	1.1129	1.17742	0.94521
25	1	1.26415	1.26415	1	1.30189	1.15094	1.13115
27	1	1.41509	1.39623	1.01351	1.30909	1.36364	0.96
29	1	1.20635	1.20635	1	1.20313	1.17188	1.02667
36	1	1.18333	1.16667	1.01429	1.06897	1.24138	0.86111
37	1	1.16393	1.27869	0.91026	1.15	1.26667	0.90789
12	2	1.18644	1.16949	1.01449	1.18333	1.11667	1.0597
13	2	1.15094	1.22642	0.93846	1.12963	1.18519	0.95313
14	2	1.16667	1.25926	0.92647	1.18519	1.24074	0.95522
15	2	1.26667	1.37778	0.91935	1.20833	1.3125	0.92063
16	2	1.31915	1.3617	0.96875	1.23529	1.27451	0.96923
17	2	1.23077	1.25	0.98462	1.29412	1.27451	1.01538
21	2	1.20536	1.26786	0.9507	1.16071	1.19643	0.97015
22	2	1.33333	1.27778	1.04348	1.26786	1.28571	0.98611
23	2	1.22917	1.27083	0.96721	1.28125	1.27083	1.0082
24	2	1.23214	1.28571	0.95833	1.22222	1.36111	0.89796
26	2	1.16364	1.16364	1	1.18519	1.22222	0.9697
28	2	1.2963	1.33333	0.97222	1.09259	1.2963	0.84286
30	2	1.24074	1.18519	1.04688	1.22222	1.24074	0.98507
31	2	1.19298	1.29825	0.91892	1.17544	1.2807	0.91781
32	2	1.12245	1.20408	0.9322	1.16	1.16	1
33	2	1.22642	1.22642	1	1.22642	1.18868	1.03175
34	2	1.125	1.16071	0.96923	1.10526	1.17544	0.9403
35	2	1.19444	1.2037	0.99231	1.14286	1.14286	1
38	2	1.22222	1.24074	0.98507	1.22642	1.24528	0.98485
39	2	1.06452	1.16129	0.91667	1.08065	1.20968	0.89333
40	2	1.30769	1.28846	1.01493	1.26923	1.26923	1
41	2	1.2549	1.27451	0.98462	1.17308	1.23077	0.95313

Note: Gender 1 is male and 2 is female.

Table 2 The average digit ratios according to gender

	Subjects	
	Men	Women
L 2D:4D	0.986	0.973
R 2D:4D	0.962	0.966
L2D:5D	1.227	1.215
R2D:5D	1.233	1.192
L4D:5D	1.244	1.249
R4D:5D	1.233	1.235

Note: All of the ratios except the ratios except the two 4D:5D ratios were expected to be higher for women. However, results are inconsistent with this hypothesis. Only the R 2D:4D, L 4D:5D and R 4D:5D were greater for women. This is almost opposite what was expected.

Table 3 The number of incorrect guesses in the Reading the Mind in the Eyes test

Number	Incorret	Gender
11	8	1
12	8	2
13	8	2
14	14	2
15	10	2
16	18	2
17	16	2
18	19	1
19	17	1
20	12	1
21	12	2
22	10	2
23	14	2
24	14	2
25	15	1
26	8	2
27	16	1
28	13	2
29	14	1
30	10	2
31	7	2
32	14	2
33	14	2
34	15	2
35	10	2
36	8	1
37	16	1
38	16	2
39	12	2
40	4	2
41	9	2

Note: Men are gender 1 and women are gender 2.

Table 4 Performance on the dart-throwing task.

Number	Average	Gender
11	7.18	1
12	7.075	2
13	11.38	2
14	7.86	2
15	7.48	2
16	11.22	2
17	6.7	2
18	7.19	1
19	6.92	1
20	5.82	1
21	9.3	2
22	10.2	2
23	10.6	2
24	8.12	2
25	10.1	1
26	11.08	2
27	9.84	1
28	12.51	2
29	4.39	1
30	7.91	2
31	9.98	2
32	5.85	2
33	9.08	2
34	13.46	2
35	13.83	2
36	4.55	1
37	7.825	1
38	9.08	2
39	7.18	2
40	6.42	2
41	10.94	2

Note: Upon closer inspection, it is seen that the earlier performers at least at face value, performed better than the later groups, perhaps due to the confounding.

Table 5 Shows the correlation between the four new ratios, the average difference from the bulls-eye and the total missed on the RME Test

Correlations

		L2D5D	L4D5D	R2D5D	R4D5D	TAVG	TOTAL
L2D5D	Pearson Correlation	1	.087	.374*	.189	-.134	.203
	Sig. (2-tailed)		.643	.038	.308	.473	.272
	N	31	31	31	31	31	31
L4D5D	Pearson Correlation	.087	1	.504**	.587**	.150	.340
	Sig. (2-tailed)	.643		.004	.001	.421	.061
	N	31	31	31	31	31	31
R2D5D	Pearson Correlation	.374*	.504**	1	.310	.000	.250
	Sig. (2-tailed)	.038	.004		.090	1.000	.174
	N	31	31	31	31	31	31
R4D5D	Pearson Correlation	.189	.587**	.310	1	-.008	.077
	Sig. (2-tailed)	.308	.001	.090		.966	.679
	N	31	31	31	31	31	31
TAVG	Pearson Correlation	-.134	.150	.000	-.008	1	-.013
	Sig. (2-tailed)	.473	.421	1.000	.966		.943
	N	31	31	31	31	31	31
TOTAL	Pearson Correlation	.203	.340	.250	.077	-.013	1
	Sig. (2-tailed)	.272	.061	.174	.679	.943	
	N	31	31	31	31	31	31

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Note: TAVG stands for Targeting Average, "Total" refers to the total missed on the RME. Notice that the four new ratios do not correlate with either of these significantly.

Table6 The correlation of all the digit ratios to mistake on the RME and deviations from the bulls-eye.

Correlations

		L2D5D	L4D5D	R2D5D	R4D5D	TAVG	TOTAL	L2D4D	R2D4D
L2D5D	Pearson Correlation	1	.087	.374*	.189	-.134	.203	.098	.178
	Sig. (2-tailed)		.643	.038	.308	.473	.272	.599	.339
	N	31	31	31	31	31	31	31	31
L4D5D	Pearson Correlation	.087	1	.504**	.587**	.150	.340	-.163	.018
	Sig. (2-tailed)	.643		.004	.001	.421	.061	.381	.923
	N	31	31	31	31	31	31	31	31
R2D5D	Pearson Correlation	.374*	.504**	1	.310	.000	.250	.310	.657**
	Sig. (2-tailed)	.038	.004		.090	1.000	.174	.090	.000
	N	31	31	31	31	31	31	31	31
R4D5D	Pearson Correlation	.189	.587**	.310	1	-.008	.077	-.098	-.509**
	Sig. (2-tailed)	.308	.001	.090		.966	.679	.601	.003
	N	31	31	31	31	31	31	31	31
TAVG	Pearson Correlation	-.134	.150	.000	-.008	1	-.013	-.026	.017
	Sig. (2-tailed)	.473	.421	1.000	.966		.943	.888	.930
	N	31	31	31	31	31	31	31	31
TOTAL	Pearson Correlation	.203	.340	.250	.077	-.013	1	-.199	.176
	Sig. (2-tailed)	.272	.061	.174	.679	.943		.284	.344
	N	31	31	31	31	31	31	31	31
L2D4D	Pearson Correlation	.098	-.163	.310	-.098	-.026	-.199	1	.342
	Sig. (2-tailed)	.599	.381	.090	.601	.888	.284		.060
	N	31	31	31	31	31	31	31	31
R2D4D	Pearson Correlation	.178	.018	.657**	-.509**	.017	.176	.342	1
	Sig. (2-tailed)	.339	.923	.000	.003	.930	.344	.060	
	N	31	31	31	31	31	31	31	31

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Note: TAVG stands for Targeting Average, "Total" refers to the total missed on the RME. Notice that these two do not significantly correlate with any of the digit ratios.