PERGAMON

Personality and Individual Differences 30 (2001) 579–586

PERSONALITY AND INDIVIDUAL DIFFERENCES

www.elsevier.com/locate/paid

Cognitive pattern and dermatoglyphic asymmetry

Doreen Kimura *, Paul G. Clarke

Department of Psychology, Simon Fraser University, 8888 University Drive, Burnaby, British Columbia, Canada, V5A 1S6

Received 1 October 1999; received in revised form 20 February 2000; accepted 15 March 2000

Abstract

Right-handed subjects were classified by the number of ridges on left and right fingertips as left-higher (L>) or right-higher (R>). As in previous studies, L> subjects of both sexes scored higher than R> subjects on tasks typically favouring females (feminine tasks). However, masculine characterization of tests did not relate consistently to direction of dermatoglyphic asymmetry. Instead, two verbally-presented reasoning tasks (inferences, math aptitude) were advantaged in R> subjects compared to L>. Since fingerprints are formed by the fourth fetal month, the data support suggestions that significant components of our cognitive pattern are programmed very early in life. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Cognitive; Asymmetry; Sex differences; Dermatoglyphics; Fingerprints

1. Introduction

It is well established that men and women differ in their patterns of cognitive strengths, with men, for example, excelling at certain spatial, and at math reasoning tests, for convenience designated as 'masculine' tasks. Women, in contrast, excel at certain verbal fluency, verbal memory and perceptual scanning ('feminine') tests (see Kimura, 1999 for review).

Previous research has also demonstrated a relation between the direction of asymmetry in number of ridges on the left and right fingertips, and cognitive pattern. Those persons with a higher count on the right hand (R>), the prevailing asymmetry in both men and women, had higher scores on 'masculine' tasks than groups with a left-higher count (L>), the minority pattern (Kimura and Carson, 1995). In contrast, the L> group performed better on 'feminine' tests. On 'neutral' tests, those that typically do not show sex differences, there was no significant effect of asymmetry.

* Corresponding author. Tel.: +1-604-291-3356; fax: +1-604-291-3427.
E-mail address: dkimura@sfu.ca (D. Kimura).

PII: S0191-8869(00)00056-8

There were, however, some anomalies in the data which raised the question whether the terms masculine, feminine and neutral best described the association with finger-ridge asymmetry. First, a mental rotation test that yields a large and reliable difference in favour of men showed no effect of rightward asymmetry; whereas a test of math reasoning did show such effect. Second, of the two tests showing the largest effect of rightward asymmetry, one was a neutral test (inferences), that is, it did not and typically does not yield a sex difference. It appeared that two reasoning tasks, inferences and math aptitude, both showed the strongest positive association with rightward asymmetry.

The present study was an attempt to replicate and extend these findings. In addition to administering many of the tests used in the previous study, we added another female-favouring (feminine) task — verbal memory.

2. Methods

2.1. Subjects

We tested 19 L > women aged 21.0 (2.9), 19 L > men aged 21.7 (3.1), 23 R > women aged 21.1 (2.8), and 20 R > men aged 22.1 (3.4), making a total of 81 subjects.

2.1.1. Selection procedure

Right-handed undergraduates only, whose first language was English, were solicited for this study at Simon Fraser University. All subjects were initially screened via fingerprinting. A table was set up in a well-trafficked area on campus, and paid volunteers were fingerprinted, and asked to provide name, telephone number and programme of study for future contact. This was also an occasion to check their writing hand, their sex, and to note if they were not Caucasian. To maintain homogeneity across subject groups, only Caucasian subjects (who were the majority) were asked to return for the next phase of the study.

The fingerprints for the thumb and little finger of each hand were examined and a count of the number of ridges was determined (see Kimura & Carson, 1995 for details of fingerprinting and counting). A difference between hands of two or more was considered asymmetric and the subject classified as either L >, R >, or no difference. Scoring of fingerprints was concurrent with the fingerprinting phase, which went on for several weeks, in order to obtain roughly equal and adequate numbers of men and women in each group.

Because there were, as always, fewer L > subjects, all were asked to return for the second phase of the study, and these subjects were then matched with R > subjects for sex and programme of study. Nearly all invited subjects returned for testing, which included cognitive tests, and also required the subject to leave a sample of saliva for later hormonal assay. (The assays will be the topic of a separate paper.) All subjects were paid for their participation.

2.2. Cognitive tests

The cognitive tests were categorized a priori, on the basis of the Kimura and Carson study. We retained the category ‘feminine’ tests, but not that of ‘masculine’ and ‘neutral’. For the latter two categories, we substituted ‘spatial’, ‘reasoning’, and ‘general intelligence’ tests.

2.2.1. Feminine tests

These are tests on which women usually outperform men.

Things red. This was a version of the things categories test from the ETS kit (Ekstrom, French, Harman & Dermen, 1976). Subjects were asked to write the names of as many things as possible that were always red, or red more often than any other colour. There was a 3-min time limit, and no penalty for incorrect responses.

Identical pictures (part 1). (Ekstrom et al., 1976) This is considered a test of perceptual speed. A target item is given and the S must find the identical item out of five choices. Score is the total correct in $1\frac{1}{2}$ min, no adjustment for errors. Maximum score is 48.

California verbal learning test. (Delis, Kramer, Kaplan & Ober, 1987) Sixteen words were presented via tape recorder, in the experimenter's voice, after which S recalled them in any order. Three such trials were given, and the score was the total number correct over all trials. Half marks were given for words that were correct except for the singular/plural feature. Maximum score is 48.

2.2.2. Spatial tests

Both of these are tests on which men usually outperform women.

Mental rotation. (Vandenberg & Kuse, 1978) The subject is presented with a probe item, and four choices, two of which are the same item as the probe, but rotated. The subject must pick two items, and scores on each item range from 0 to 2, with correction for guessing. Four minutes are allowed for 12 trials, with a maximum score of 24. This test yields the largest sex difference so far found on standardized tests.

Paper folding (part 1). (Ekstrom et al., 1976) The subject is asked to imagine that a given picture of a folded paper is punctured through with a pencil. S/he must then pick the *correct* item out of five, depicting the view when unfolded. Time allotted is 3 min. Correction for guessing is ♯correct minus 1/5 the ♯incorrect. Maximum score is 10.

2.2.3. Reasoning tests

Inferences (part 1). (Ekstrom et al., 1976) This requires the subject to choose the correct inference from given statements of fact, out of five choices. Score is ♯correct minus 1/5 ♯incorrect. Time allotted is 6 min, and maximum score is 10. Typically, there is no sex difference on this task.

Mathematical aptitude (part 1). (Ekstrom et al., 1976) A math problem is presented in a sentence, and the correct answer is chosen from five options. Score is ♯correct minus 1/5 ♯incorrect. Ten minutes is allotted for a maximum score of 15. On this test, men usually obtain higher scores.

2.2.4. General intelligence tests

These do not typically show sex differences.

Raven's matrices. This is an abbreviated version of the Raven's standard progressive matrices. Maximum score is 15, with no correction for guessing. There is no time limit, but total time was recorded.

Advanced vocabulary (part 1). (Ekstrom et al., 1976) The best synonym for a target word must be selected, from five choices. Score is ♯correct minus 1/5 ♯incorrect. Four minutes is allotted for a maximum score of 18.

3. Results

3.1. Conversion to z scores

The mean score for all 81 subjects was calculated for each test. Because maximum scores differed widely across different tests, standard or z scores (difference of each score from the mean in standard deviation units) were then calculated for each test for each subject. The tests were then combined into composites for each test type. For example, for 'spatial' tests, the two z scores were averaged for each subject, to yield a *spatial* composite z score. This permitted the comparison of the effects of sex and of asymmetry group, across different test types. Composite scores also yield more reliable measures of an ability than do individual tests (Epstein, 1980; Ghiselli, 1964).

3.2. General intelligence measures

The scores for general intelligence tests were not included in the overall analysis, since they were not expected to, nor did they, yield any differences between men and women or between asymmetry groups. The F ratio for this composite across sex was 1.40 (df = 1,79), which is not significant. The F ratio for L–R asymmetry groups was 0.32 (df = 1,79), also not significant.

3.3. Overall analysis

The remaining composite scores were then analyzed across sex (male, female), asymmetry (L >, R >), and test-types ('feminine', 'spatial', and 'reasoning'). The first two were between-subjects, and the latter within-subjects measures.

As expected, since tests were included which favoured either males or females, there were no significant main effects for sex ($F[1, 77] = 0.40$), nor for asymmetry ($F[1, 77] = 0.07$).

Also as expected, there was a significant interaction between test-type and sex ($F = 7.94$, $p < 0.001$), reflecting the fact that men outperformed women on the spatial composite ($F = 7.03$, $p < 0.01$), whereas women outperformed men on the feminine composite ($F = 5.35$, $p < 0.02$). There was no significant effect of sex on the reasoning composite. These results are depicted in Fig. 1.

There was also a significant interaction between test-type and directional asymmetry ($F = 3.51$, $p < 0.03$), reflecting primarily the fact that R > subjects performed better on the reasoning composite, and L > subjects on the feminine composite. There was no significant interaction between test-type, asymmetry and sex, indicating that the effect of asymmetry was not different for men and women.

The relation between directional asymmetry and performance on the three test-types is depicted in Fig. 2.

3.4. Asymmetry and reasoning-vs-feminine tests

Individual post hoc comparisons between L > and R > groups yielded no significant differences for either feminine ($F = 1.70$, $p < 0.20$) or reasoning ($F = 3.77$, $p < 0.06$) composites.

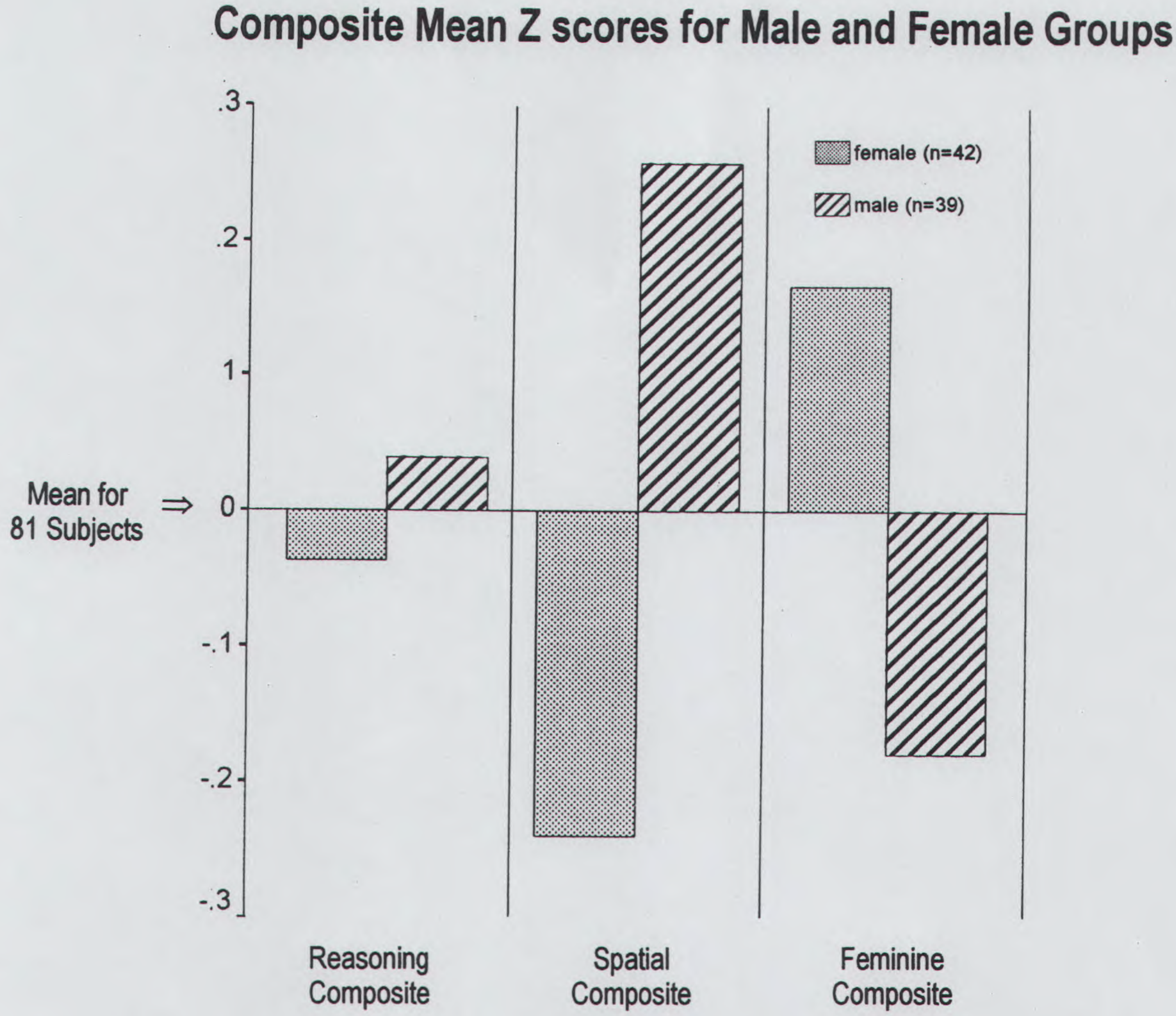

Fig. 1. Performance on cognitive tasks by men and women.

However, these differences were in opposite directions, as can be seen in Fig. 2. Therefore, a reasoning-minus-feminine *z* score was calculated for each subject, and the means of the L > and R > groups were compared with a *t*-test. This difference was highly significant ($t = 2.72$, df = 79, $p < 0.01$), confirming that cognitive pattern differed between directional asymmetry groups.

4. Discussion

This study confirmed previous reports that direction of finger-ridge-count asymmetry is related to cognitive pattern (Kimura & Carson, 1995; Sanders, Aubert & Kadam, 1995). As in the earlier

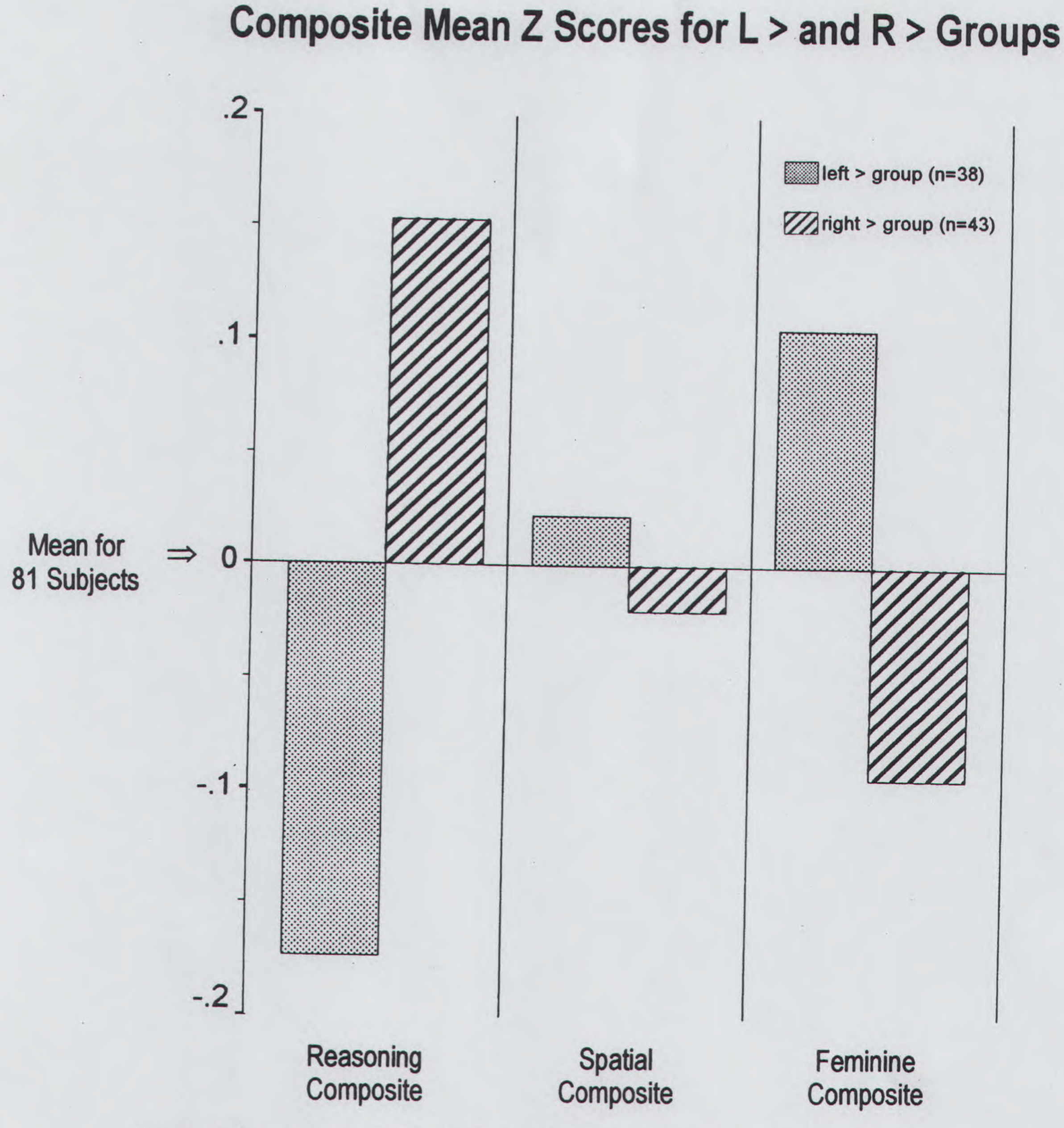

Fig. 2. Performance on cognitive tasks by leftward and rightward asymmetry groups.

study from our laboratory, tasks which generally favour women were performed better by the group of subjects with a higher count on the left hand; whereas two reasoning tasks (both presented in sentence format) were performed better by the group with a higher count on the right. In the present study, we added a verbal memory task, which reliably favours women, to those labelled feminine.

However, as in our previous study, not all tasks favouring men showed better performance by the R > group. Thus the spatial composite, which included a mental rotations test that yields a large sex difference favouring males, showed no significant effect of asymmetry (see Fig. 2). The reasoning composite, in contrast, which included only one test typically favouring males (math aptitude), did show such an effect. It appears that the masculine and neutral characterization of tests proposed in our first study, does not fit well with the cognitive pattern related to asymmetry, although the feminine label still appears to have some unifying value. Only further research will determine whether all or most female-favouring tests will behave in such a consistent fashion.

The heterogeneity of male-favouring cognitive tests as they relate to dermatoglyphic asymmetry is consistent with what we know about behavioural masculinization in general. That is, masculinization is complex and multi-faceted, with different aspects hormonally influenced at different prenatal periods (Goy, Bercovitch & McBrair, 1988). In normal human adults also, the relation between sex hormone levels and cognitive pattern, while showing large consistencies, is not the same for all masculine tasks.

Nevertheless, L > and R > groups of subjects, since they show consistently different cognitive patterns, must have somewhat different brain organizations. In an earlier attempt to discover what the directional asymmetry signifies for brain patterns, we ruled out a simple directional correlation between inferred hemispheric development and finger-ridge count. That is, a leftward asymmetry did not appear to signify greater left-hemisphere facilitation, as measured by dichotic listening (Hall & Kimura, 1994). Instead, we found evidence that commissural function, as measured by inter-hemispheric transmission, was enhanced in the L > group compared to the R > (Saucier & Kimura, 1996).

While one might make a case for enhanced communication between hemispheres being an advantage for ideational fluency, and even verbal memory, it is not clear how or why it should advantage perceptual speed. Nor is it apparent how reduced inter-hemispheric transmission, assumed to be present in the R > group, would enhance reasoning ability. So there are still important unanswered questions about the neural basis for the group differences we see.

However, we emphasize that finger-ridge patterns, including ridge-count asymmetry, are determined by about the fourth fetal month. This implies that the cognitive patterns associated with leftward or rightward asymmetry are also strongly influenced this early in life. Since socialization processes are not operating at that time, the results are consonant with other data suggesting an early biological contribution to cognitive pattern (see Kimura, 1999 for review).

Acknowledgements

This research was supported by grants to D. Kimura from the Natural Sciences and Engineering Research Council, and the Medical Research Council, Ottawa, Canada.

References

Delis, D. C., Kramer, J. H., Kaplan, E., & Ober, B. A. (1987). *The California Verbal Learning test*. San Antonio, Texas: Psychological Corporation.

Ekstrom, R. B., French, J. W., Harman, H. H., & Dermen, D. (1976). *Kit of factor-referenced cognitive tests*. Princeton, NJ: Educational Testing Service.

Epstein, S. (1980). The stability of behavior. II. Implications for psychological research. *American Psychologist, 35*, 790–806.

Ghiselli, E. E. (1964). *Theory of psychological measurement*. New York: McGraw-Hill.

Goy, R. W., Bercovitch, F. B., & McBrair, M. C. (1988). Behavioral masculinization is independent of genital masculinization in prenatally androgenized female rhesus macaques. *Hormones and Behavior, 22*, 552–571.

Hall, J. A. Y., & Kimura, D. (1994). Dermatoglyphic asymmetry and sexual orientation in men. *Behavioral Neuroscience, 108*, 1203–1206.

Kimura, D. (1999). *Sex and cognition*. Cambridge, Mass: MIT Press.

Kimura, D., & Carson, M. W. (1995). Dermatoglyphic asymmetry: relation to sex, handedness and cognitive pattern. *Personality & Individual Differences, 19*, 471–478.

Sanders, G., Aubert, F., & Kadam, A. (1995). Asymmetries in finger ridge count correlate with performance on sexually dimorphic tasks in children and adults. In *Paper Presented at Twenty-first Annual Meeting of the International Academy of Sex Research, Provincetown, Mass.*

Saucier, D. M., & Kimura, D. (1996). Dermatoglyphic asymmetry is related to perceptual asymmetry and to interhemispheric transmission. *Laterality, 1*, 185–198.

Vandenberg, S., & Kuse, A. R. (1978). Mental rotations: A group test of three-dimensional spatial visualization. *Perceptual & Motor Skills, 47*, 240–245.