Original Article

AN IMPROVED METHOD FOR QUANTITATIVE ASSESSMENT OF FAMILIAL SINISTRALITY AS APPLIED TO COMPARE HAND DOMINANCE ITEMS

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Summary

In all the investigations of human laterality, assessment of subjects' handedness is an initial and very important step, which could be performed by three different ways. One of them, determination of handedness using the writing hand only, being a simple and quick approach, is widely used and prominent authors consider it the best method in this respect. However, it could be suspected that results obtained in this way are strongly biased by the familial and educational pressure towards right-hand writing which is far from being entirely overcome. The aim of the present study was to apply an improved version of our method for quantitative assessment of familial sinistrality to compare 13 handedness items with each other, as well as to compare writing hand as a single indicator to the efficiency of the questionnaire as a whole. The results showed that writing is inferior to the remaining 12 hand preference items and that the difference between right- and left-handers is much more genetically grounded than the difference between the right- and left-hand writers. It was concluded that the question posed in the headline must be negatively answered and that writing hand is absolutely inappropriate as a single measure of handedness.

Key words: laterality, handedness, writing, familial sinistrality

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Introduction

One of the characteristics distinguishing mankind from the animal world is that the great majority of humans, approximately 90 %, are right-handed. Probably, some genetic change took place early in the course of the hominid evolution that shifted the distribution of the handedness sharply in favor of the right hand [1]. In the ontogenesis, the earliest manifestation of handedness was the conformity between the prenatal sucking of the right or left thumb and the postnatal handedness [2].

In all the investigations in the field of human laterality, assessment of subjects' handedness is an initial and important step. It could be performed in three main ways: self-determination, on the basis of writing hand and using questionnaires. It seems that the simplest and quickest approach is to merely ask the subject which hand he/she uses for writing [3, 4]. It was even claimed that handedness is best measured in that way [5]. However, though the familial and educational pressures to write with the right hand are less pronounced today than several generations ago, these pressures are far from being entirely overcome [6, 7]. Therefore, it could be suspected that, being considerably biased by educational factors, handedness assessed through writing hand as a single measure does not reflect well biological realities.

An important part of the differences in cognitive and motor asymmetries not only between, but also inside handedness categories is considerably influenced by the presence, if any, of non-right handers (NRHs) among the subject's biological relatives – presence, referred to as Familial Sinistrality (FS). However, criteria to classify subjects concerning their FS differ largely from each other. Most of them are purely qualitative, dichotomizing subjects into FS + and FS – and none of used methods considered genealogical closeness of the NRH relatives to the subject. In previous studies we introduced a quantitative approach, based on the genealogical proximity of every single one of the NRH relatives to the subject. As far as many authors insisted the possible impact of the family size on FS to be prevented [8, 9], recently we modified the method by relating the value of the proposed index to the sum of the numbers of considered blood relatives, either RH or NRH.

During the last decade we studied several functional and morphological asymmetries [10, 11, 12, 13] in right, mixed and left-handers. The aim of the present study was to apply the improved version of the method to compare the 13 items of the chosen questionnaire with each other, as well as the efficiency of the writing hand as a single measure of handedness to that of the questionnaire as a whole.

Materials and Methods

Subjects

All the students from randomly selected Bulgarian secondary schools were orally questioned which hand they used to write, draw, throw, cut with scissors, hammer a nail, and use a screwdriver. Those who preferred the left hand in any one of these activities were tested on the inventory of Chapman and Chapman [14]. Among those who preferred the right hand for all the six activities, 264 randomly selected presumed right-handers were tested on the same questionnaire. The sampling was directed at obtaining a high proportion of non-right handed (NRH) subjects and equal proportions of male and female participants. The total sample reached 870 subjects (435 of either sex), aged from 14 to 19 years (mean = 16.6 years , SD = 1.0 year). All the subjects and the parents of the 675 minors among them gave their informed consent.

Hand preference

In Chapman and Chapman's questionnaire [14] each subject had to fill in whether he/she preferred the right hand (thereafter scored "1"), either hand (scored "2") or the left hand (scored "3") to : 1.draw; 2. write; 3. use the bottle opener; 4. throw a ball to hit a target; 5. use a hammer; 6. use a toothbrush; 7. use a screwdriver; 8. use an eraser; 9. use a tennis racket; 10. cut with scissors; 11. hold a match to strike it; 12. stir a can of paint, and 13. on which shoulder he/she would rest a bat before swinging. Subjects with scores from 13 to 17 were designated as right-handers (RH), from 18 to 32 as mixed handers (MH), and from 33 to 39 as left-handers (LH). The sample included 264 RH, 246 MH and 360 LH.

Familial sinistrality

The main priority of our method is that it considers the number of subject's RH and NRH relatives along with the blood proximity of each of them to the subject. In its previous version, the cumulative index of familial sinistrality (CIFS) was calculated by summing up the subject's coefficients of relatedness [15] with every single one of his/her NRH biological relatives:

$$CIFS = \sum_{i=1}^{k_1} (1/2)^n + \sum_{j=1}^{k_2} [2(1/2)^n]$$

To be absolutely sure that the impact of the family size was prevented, in the new formula this expression was related to the sum of numbers of all the considered relatives, each particular number divided by the corresponding degree of blood relationship:

$$CIFS = 10\{\sum_{i=1}^{k_1} (1/2)^n + \sum_{j=1}^{k_2} [2(1/2)^n]/[r_1 + r_2/2 + r_3/3 + r_4/4 + r_5/5],$$

where $\mathbf{k_1}$ is the number of direct line NRH relatives, $\mathbf{k_2}$ is that of collateral line ones, **n** stands for degrees of relationship, and $\mathbf{r_1}$, $\mathbf{r_2}$, etc. are the general numbers of considered relatives of each degree. Degrees must be counted by generation-to-generation steps from the subject to his NRH progenitor (for direct-line relatives) and from the subject to his NRH relative via their closest common progenitor (for collateral line ones). In this case, since degrees are counted once but the common progenitors are two, the multiplier "2" considers both of them.

Results

Looking for the biologically grounded differences between subjects having answered "right", "either" and "left", the mean values of CIFS in these three groups were compared, each item separately. These values increased distinctly from respondents "right" towards respondents "left". To assess the significance of these observations, 13 consecutive one-way ANOVAs were performed with each item as Factor and CIFS as Depending variable (Table 1). In all items we had df (2, 867); in 11 of them F varied from 13.015 to 27.470 and the investigated dependence was highly significant (p = .000). In item 13, "shoulder", we obtained F = 3.045 and p=.048, i.e., the same trend was significant, although at much lower level. In an only item, 2, "writing", this dependence was far from being significant (F = 2.330, p = .098).

Table 1. Results of the 13 one-way ANOVAs concerning the dependences of each item hand preferences on the Cumulative Index of Familial Sinistrality

No	Item	d.f.	F	p value
1.	drawing	2, 867	13.015	0.000
2.	writing	2, 867	2.330	0.098 n.s.
3.	opener	2, 867	25.922	0.000
4.	throwing	2, 867	19.982	0.000
5.	hammer	2, 867	17.778	0.000
6.	toothbrush	2, 867	23.862	0.000
7.	screwdriver	2, 867	26.540	0.000
8.	eraser	2, 867	27.470	0.000
9.	tennis racket	2, 867	13.997	0.000
10.	scissors	2, 867	24.541	0.000
11.	match	2, 867	18.580	0.000
12.	stirring	2, 867	17.211	0.000
13.	shoulder	2, 867	3.045	0.048

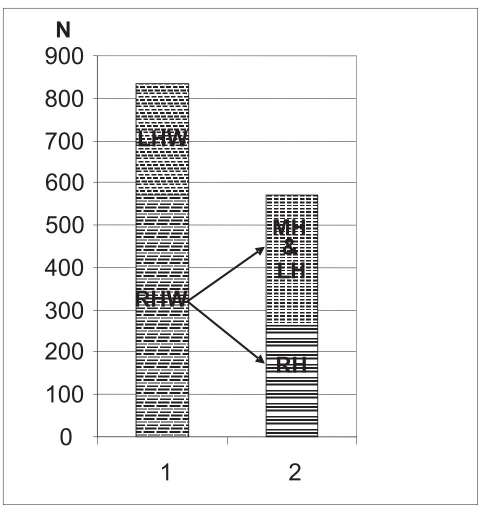

Fig.1. Differences in the means of CIFS between right- and left-hand writers (on the left) and between NRH (MH & LH) and RH right-hand writers (on the right):LHW vs. RHW, difference of .77, t = 2.15, p = .04; MH & LH vs. RH, difference of .257, t = 6.63, p = .000

As it could be seen from Material and Methods, our sample comprised 360 LH vs. 264 RH, i.e., it was considerably weighted towards left-handedness. When the sample was evaluated using the writing hand only, it comprised 570 right-hand writers vs. 262 left-hand writers. Obviously, the inventory and the writing hand determined one and the same sample as weighted in opposite directions. Logically, this contradiction aroused the question whether right-handedness was underestimated by the inventory or if it was overestimated by the writing hand as an only measure. Not only the best, but seemingly the only way to answer this question, was to determine which of these two approaches was better biologically grounded and CIFS turned out to be an efficient tool to do that. It could be seen in Figure 1 that the means of CIFS in the right-hand and the left-hand writers, .328 and .405, correspondingly, differed significantly (difference of .077, d.f. 1, 830, t = 2.15, p = .04). Inside the right-hand writing subjects, these belonging to the RH category and those belonging to the NRHs showed means of CIFS of .189 and .446, correspondingly (difference of .257, d.f. 1, 568, t = 6.625, p=.000). The more than three-fold excess of the second difference over the first and its much higher statistical significance, despite the much lower number of cases, categorically showed that the questionnaire as a whole is much more trustworthy as compared to the writing hand as an only measure.

Discussion

We have unpublished results, showing that writing hand is inferior to all the remaining items of the chosen inventory in all the investigated respects. The present results, obtained using the improved version of CIFS, give additional support of our previous conclusions.

First of all, writing was the only item, whose interdependence with CIFS was not statistically significant. Secondly, the difference between the means of the index in the RH and NRH inside the right-hand writers is much bigger and much more statistically significant than that between right- hand and left-hand writers. Bearing in mind that CIFS reflects the genetic predisposition towards left-handedness, it is clear that the difference between handedness categories as determined through the questionnaire is much better biologically well-grounded than the difference between right- and left-hand writers.

In the light of these results, the considerable contradiction between the handedness distributions of the sample as revealed by the writing hand and by the inventory could be explained through a massive "pouring" of LH and MH into an artificially enlarged group of right-hand writers due to the social pressure towards right-hand writing.

In any case, unlike some other authors [e.g., 16, 17] we would not go so far as to eliminate this item from the questionnaires. As a component of handedness, writing has acquired a kind of "symbolic" presence. If a lecturer notices that six of his students take their lecture notes with the left hand, he would say to himself "Well, there are six left-handers in this hall !" without further considering the qualities of the item. Besides, such a "revolutionary" change in inventories would hardly be unanimously accepted by investigators and would rather increase difficulties to compare results of different studies.

Conclusion

Without eliminating writing from the handedness inventories, it is necessary not to overestimate this item, to always have in mind its numerous shortcomings and inferiorities and, at the first place, the fact that probably in numerous populations, like in our sample, social pressures are much more decisive than biological realities for the proportions of right- and left-hand writers. Therefore, writing is absolutely inappropriate as a single measure of handedness. If, in certain circumstances, e.g. to spare time in mass population studies, the use of such a single measure is judged inevitable, hammering will be incomparably better than writing as a single measure of handedness.

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