PROBLEMS IN THE ASSESSMENT OF HAND PREFERENCE

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INTRODUCTION

Evaluation of hand preference is relevant in those psychological studies that aim to investigate: (a) the relationship between hand preference and cerebral organization; (b) the relationship between hand preference and deficits of different nature; (c) patterns of hand preference in populations of different geographical provenience. In order to understand this kind of relationship, performance on cognitive tasks or the incidence of specific disorders, like reading disability or immune diseases (see e.g. Geschwind and Behan, 1982), are compared between right-handers and left-handers. Moreover, in order to explore the role of biological and cultural factors in determining hand-preference, percentages of right and left handers are obtained across different populations.

Whatever relationship one wants to investigate, the starting point is the evaluation of hand preference, which is not a straightforward matter. It depends, in fact, on the choice of the assessment method utilized: usually preference questionnaires, self-reports or performance tests (Porac and Coren, 1981). Also when the choice is restricted to questionnaires, which is the assessment method most widely used, there is still a wide range of arbitrariness since questionnaires may vary in number and kind of items. In some extreme example handedness has been evaluated by means of a 75 items questionnaire (e.g. Provins, Milner and Kerr, 1982) or simply by asking to the subject which hand he or she uses for writing (e.g. Silva and Satz, 1979). Also when the number of items is kept constant, assessment of handedness depends on the kind of items utilized (Provins et al., 1982). In addition, definition of right and left handers has a degree of arbitrariness that depends on the fact that handedness is considered as a continuous variable (Porac and Coren, 1981) and the partition of a continuum in two or more parts depends on the criterion adopted. Usually right handers are considered those subjects that perform more activities

(at least one) with the right hand than with the left hand. By contrast, in some studies right handers are considered those subjects that perform all the activities with the right hand (e.g. Annett, 1967; Geschwind and Behan, 1982).

All these considerations are shown in Table I, where the results obtained in previous studies on pattern of hand preference in different populations are reported. Specifically, the percentages of left-handers are not easily comparable since they are obtained on the basis of different evaluation methods and groupings. At present it is not clear which is the most suitable questionnaire. This problem has been considered in previous papers (Bryden, 1977; McFarland and Anderson, 1980; Oldfield, 1971; Provins et al., 1982).

The aim of the present study is to reconsider and to stress the effect of item selection in determining the pattern of hand preference. Our starting point has been Oldfield's (1971) study, since his questionnaire, consisting of ten items selected among 20 on the basis of qualitative and quantitative considerations, is the most widely used (see Citation Index). We decided to reconsider Oldfield's selection in order to: (a) verify if hand preference distribution in a different geographical population would result in the same selection proposed by Oldfield; (b) provide a selection method free from qualitative considerations; (c) check if "writing" and "drawing" present in the Oldfield's questionnaire would be included in the selection resulting in this study. The reason for this last point is due to the fact that in a previous paper (Salmaso and Longoni, 1983) we showed that the pattern of handedness distribution is significantly modified by the presence, in the questionnaire, of these two items.

In addition this paper intends to investigate the possible influence of such variables as sex, age and previous familial sinistrality on hand preference, variables that previous studies have indicated as relevant.

Materials and Method

The Edinburgh Inventory Questionnaire was administered in the original form proposed by Oldfield (1971) and consisting of 20 items describing different hand motor activities. On the response sheet each item was followed by two columns labelled left and right. Every subject was required to mark a "+" in the appropriate column if the activity was preferentially carried out using one hand, a "++" if in no way the other hand would be used unless in a forced situation, and a "+" in both columns in case of real indifference on which hand to use. Two other questions were related to the subject's eye and foot preference. In addition subjects were asked whether they had any first-degree (father, mother, grandarents, uncle, aunt, cousins) left-handed relative and whether they ever experienced any tendency toward the use of the left-hand and whether this tendency was corrected.

TABLE I

Incidence of Left-Handedness in Different Studies

Study	Subjects	Assessment method	Left handedness criterium	% Left handers
Verhaegen et al. (1964)	1047 African children	P-3	LQ < -33	0.5
Annett (1967)	1003 British adults	Q-8 Q-12	LQ $= -100$	3.8
Annett (1970)	1576 British adults	Q-12	LQ $= -100$	4.3
Oldfield (1971)	1109 British adults	Q-10	LQ < 0	7.4
Dawson (1972)	204 Sierra Leone adults	Q-3	LQ < -33	3.4
Newcombe et al. (1973)	823 British adults	Q-7	LQ $= -100$	3.2
Briggs et al. (1975)	1599 American adults	Q-Annett	LQ < -37	9.1
Hardyck et al. (1976)	7688 American children	P-3	LQ $= -100$	9.6
Teng et al. (1976)	4143 Taiwan children and adults	Q-12	LQ $= -100$	0.4
Hatta et al. (1976)	1199 Japanese adults	Q-10	LQ $= -100$	3.1
Fleminger et al. (1977)	800 British adults	Q-Annett	LQ $= -100$ writing drawing	2.4 8.8 9.4
Peterson (1979)	1045 American adults	Self-report		
Silverberg et al. (1979)	1171 Israelian teen-agers	Q-Oldfield	LQ $= -100$	4.0
Leiber et al. (1981)	2257 American adults	Self-report		8.6
Porac et al. (1981)	5147 American and Canadian adults	Q-4	LQ < 0 LQ $=$ -100	11.8 4.0
Guaraldi et al. (1981)	2012 Italian children	P-Auzias	LQ < 0	9.9
Bryden (1982)	4882 Canadian adults	Q-5	?	10.4
Geschwind et al. (1982)	1142 British adults	Q-Oldfield modified	LQ < 0 LQ < -50	7.2 5.2
Sanders et al. (1982)	879 Hawaian adults	Q-9	LQ $= -44$	5.6
Gutezeit (1982)	968 German children	Q-53	LQ < 0	7.4
Shimizu et al. (1983)	4282 Japanese students	Q-13	LQ < -30	3.2
Salmaso et al. (1983)	1694 Italian adults	Q-Oldfield	LQ < 0	6.4

This table includes surveys with large numbers of subjects or with populations of different geographical origin. Laterality quotient values and percentages of left-handers were either explicitly stated or derived from reported data.
P-n performance test of n items
Q-n questionnaire composed of n items

The questionnaires were distributed mainly in various high school and Universities. The sample was composed of 1694 individuals (733 females and 961 males). Their ages ranged from 14 to 62 yr. with a high percentage of subjects, i.e. 83%, younger than 24 yr. No information has been asked concerning the subject's socio-economic level.

On the basis of the answer given by each subject a Laterality Quotient (LQ) was derived by subtracting the number of +'s in the left column from the number of +'s in the right column and dividing the difference by the total number of +'s and multiplying the result by 100. The calculated LQ varies from −100 to +100: −100 indicating extreme left-handedness and +100 extreme right-handedness.

RESULTS

Preferences for single items

Percentages of responses to single items and percentages of right, left and either preferences are reported in Table II. This table points out that items differentiate themselves with respect to preference distribution. In particular "writing" and "drawing" tend to dichotomize the population in

TABLE II

Percentages of Responses to Single Items and Percentages of Left (L), Either and Right (R) Preferences

	% responses	% preferences		
		L	Either	R
1. Writing	99.9	4.4	2.5	93.1
2. Drawing	99.8	5.2	2.7	92.1
3. Throwing	99.6	5.5	25.3	69.2
4. Scissors	99.8	4.3	18.8	76.9
5. Comb	99.4	4.7	34.6	60.7
6. Toothbrush	99.3	4.9	19.8	75.3
7. Knife (− fork)	99.6	6.3	14.3	79.4
8. Spoon	99.4	5.2	15.2	79.6
9. Hammer	99.6	5.7	12.4	81.9
10. Screwdriver	99.2	5.4	15.3	79.3
11. Tennis	91.1	5.2	8.2	86.6
12. Knife (+ fork)	97.5	12.4	19.6	68.0
13. Cricket bat	35.8	16.8	18.0	65.2
14. Golf club	41.7	17.3	17.6	65.1
15. Broom	95.3	21.4	33.3	45.3
16. Rake	83.8	17.4	29.0	53.6
17. Match	98.8	5.5	25.3	69.2
18. Box lid	98.8	6.4	44.8	44.8
19. Dealing cards	98.9	8.0	15.3	76.7
20. Needle	96.5	8.3	16.1	75.6
21. Foot	96.5	9.5	22.5	68.0
22. Eye	95.2	23.9	30.9	45.2

the sense that almost the whole population declares left or right preference and these two items collect the highest percentage of right preferences. On the contrary for other items like "broom" and "rake", preferences distribute more evenly among left, either and right. Furthermore it is apparent from Table II that the item "cricket bat" and "golf club" receive a low percentage of responses (35.8 and 41.7 respectively). This finding can be attributed to the little experience of Italians with these activities.

One can also observe that while foot preferences (9.5, 22.5, 68.0) are similar to hand preferences, preferences for the eye (23.9, 30.9, 45.2) are more evenly distributed.

Twenty item frequency distribution

For convenience the LQ range has been divided into 20 classes labelled from 1 to 20. In Figure 1 is represented the LQ frequency distribution calculated on the 20 items (LQ-20) and on 20 classes; males and females have been grouped together since no relationship between sex and LQ emerged (chi-square = 22.7; d.f. = 19; n.s.). The percentage of left handers (LQ $<=$ 0) results to be 6.2.

Items selection

In order to evaluate the contribution of every single item to LQ we started following the procedure proposed by Oldfield (1971) and recently utilized by Teng et al. (1979). For each item i ($1 < i < 20$) and for each class h ($1 < h < 20$) of LQ a "lambda" value was calculated by subtracting the sum of +'s under left (Nl) from the sum of +'s under right (Nr), dividing the difference by the total number of +'s (Nl + Nr) and multiplying the result by 100. In formula:

$$\text{lambda} = \frac{\text{Nr} - \text{Nl}}{\text{Nr} + \text{Nl}} \times 100$$

It follows that for each item, 20 lambda values were calculated; in Figure 2, the lambda values for 4 items are represented as a function of LQ. With reference to analogous graphs, Oldfield selected ten items basing his selection on the following considerations: (a) the concordance of the lambda algebric sign with the LQ sign, that is, an item is "good" when on average for a negative value of LQ its lambda is negative and for a positive value of LQ, its lambda is positive; (b) a personal evaluation of the "goodness" of each item made in terms of socio-economic, cultural and sex factors.

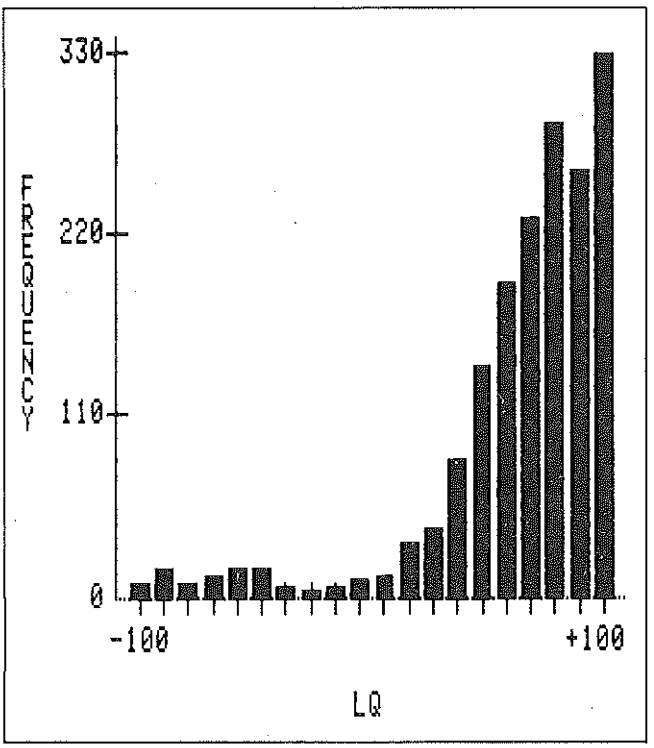

Fig. 1— *LQ-20 frequency distribution (N = 1694).*

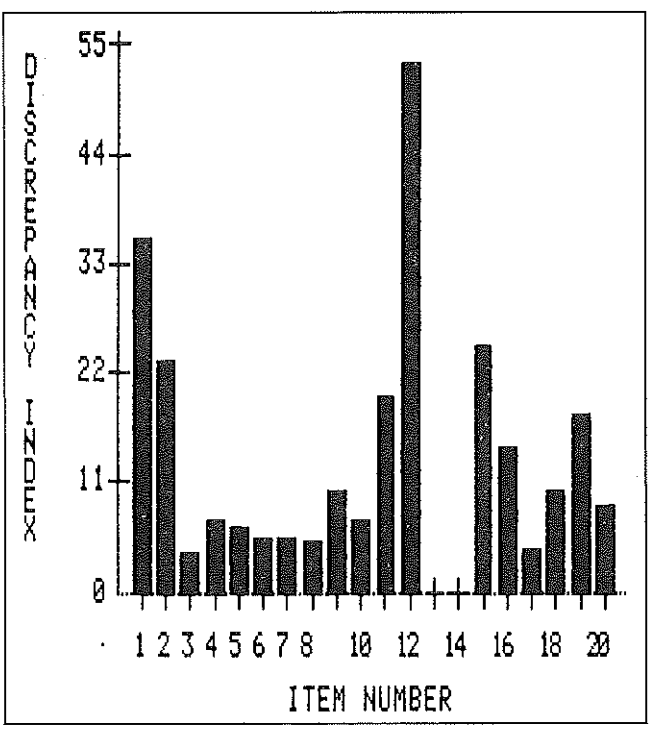

Fig. 2— *Lambda distributions for some items.*

We suggest that, in order to evaluate the contribution of every single items to the total LQ, it is possible to derive a crude quantitative index based on the following reasoning. An item is "good" if in each LQ class its lambda value is close to the corrisponding LQ mid value; for the "ideal" item its lambda value should coincide in any class with the corresponding LQ mid value and the graphic representation of lambda plotted against LQ should be a straight line. In order to evaluate how well the lambda distributions approach the LQ distribution a discrepancy index (DI) has been calculated for every item i. This index is obtained by summing over the 20 LQ classes the square of the difference between the LQ mid value (LQ') and the corresponding lambda value and averaging the result over the total number of classes. In formula:

$$DI = \frac{\sum_{h=1}^{20} (LQ'_h - lambda_h)^2}{20}$$

The smallest value that DI can take is 0. In this case the lambda values coincide with the corresponding LQ' values; the more DI increases the greater is the mismatch between LQ and lambda distribution. In Figure 3 the DI values are graphically represented for every item. Simply looking at the height of the bars of the histogram it is possible to determine the "goodness" of the items. In Table III are reported the items and their ranks according to the DI values (rank 1 corresponds to the smallest DI value). Also in this table are indicated the items included in the ten-item Oldfield questionnaire. As it is apparent the Oldfield's selection does not coincide with the ten item selection based on the ranking. More specifically six items (throwing, scissors, toothbrush, knife, spoon, match) are in common, four new items are included in our selection (comb, hammer, screwdriver, needle) and consequently four excluded (writing, drawing, broom, box lid).

While the exclusion of "box-lid" seems to be due to the fact that is the eleventh item in our rank order, "writing", "drawing", and "broom" appear to be the worst items for different reasons. In the case of "writing" and "drawing" the lambda values, in the positive axis ($LQ>0$), are consistently superior than the corresponding LQ values. On the contrary for "broom" the difference between lambda and LQ' is evident in the whole LQ range. This is in agreement with the observation previously made in reference with Table II, that hand preference for "broom" is almost equally distributed among right, either and left.

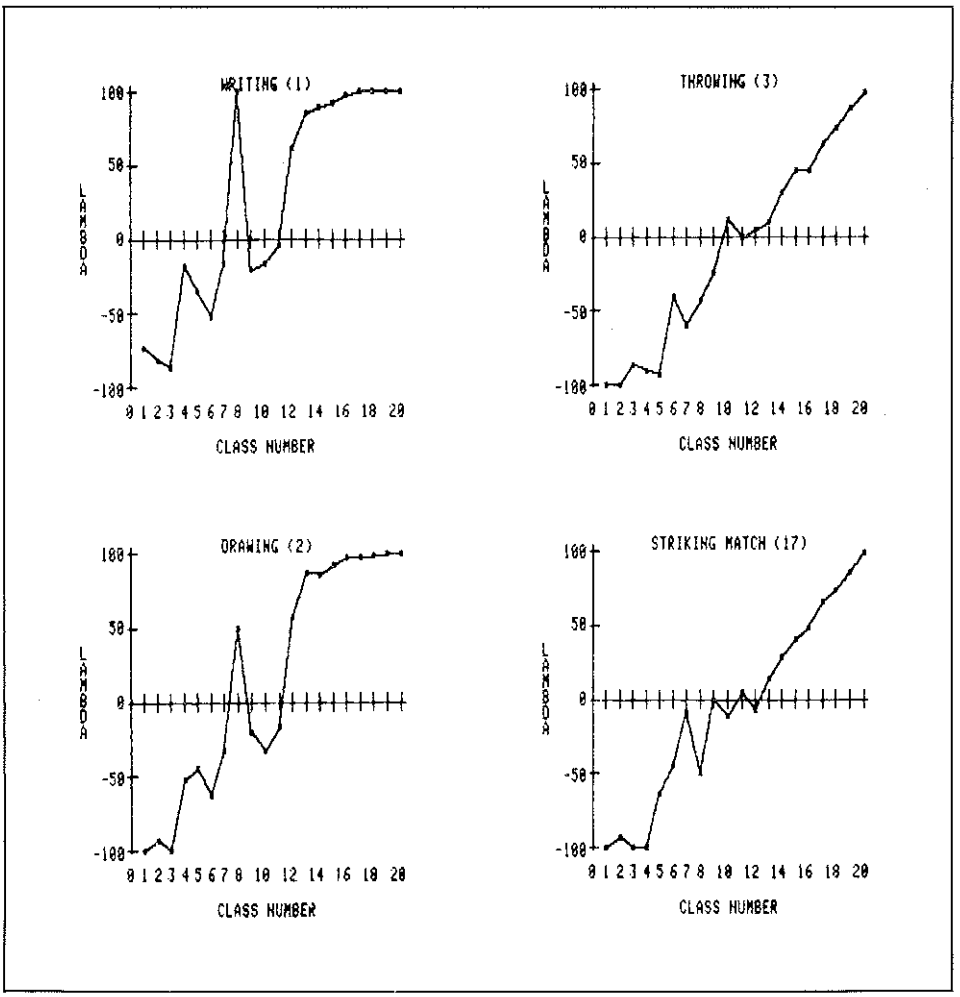

Fig. 3— *DI index for each item, with the exclusion of items 13 and 14.*

Comparison between frequency distributions

In Table IV are reported percentage frequency distributions, calculated over ten classes, for the complete twenty item questionnaire (LQ-20), the ten item Oldfield's selection (LQ-10E) and our selection (LQ-10). We decided to choose ten classes in order: (a) to have a sufficient number of frequencies in each class; (b) to obtain a rather detailed analysis of the relationship under study.

There is no significant difference between frequency distribution LQ-20 and LQ-10E. There is on the contrary a significant difference between distribution LQ-20 and LQ-10 (chi-square = 76.584; d.f. = 9; $p < .001$) and

TABLE III

Item Selection Proposed by Oldfield and the Selection Obtained in the Present Study

	Rank order	Oldfield selection	New selection
1. Writing	17	X	
2. Drawing	15	X	
3. Throwing	1	X	X
4. Scissors	7	X	X
5. Comb	6		X
6. Toothbrush	5	X	X
7. Knife (without fork)	4	X	X
8. Spoon	3	X	X
9. Hammer	10		X
10. Screwdriver	8		X
11. Tennis	14		
12. Knife (with fork)	18		
13. Cricket bat (lower hand)	-		
14. Golf club (lower hand)	-		
15. Broom (upper hand)	16	X	
16. Rake (upper hand)	12		
17. Striking match (match)	2	X	X
18. Opening box (lid)	11	X	
19. Dealing cards (card being dealt)	13		
20. Threading needle (needle or thread according to which is moved)	9		X

The rank is made according to the item's DI value.

TABLE IV

Percentage Frequency Distributions for LQ-20, LQ-10E, LQ-10

Classes	LQ-20	LQ-10E	LQ-10
1	1.5	1.7	2.5
2	1.2	1.1	1.1
3	2.0	1.4	1.2
4	.6	1.1	.5
5	.9	1.0	1.3
6	2.6	2.4	3.3
7	7.2	7.5	6.9
8	19.3	18.9	16.8
9	30.3	28.3	20.3
10	34.4	36.6	46.1

between LQ-10E and LQ-10 distributions (chi-square = 52.82; d.f. = 9; $p < .001$). As Table IV shows the most conspicuous differences appear to be in the extreme classes. On the basis of LQ-10 distribution, percentage of extreme left-handers is higher than the correspondent percentage in LQ-10E (2.5% vs. 1.7%) also the percentage of extreme right-handers is higher (46.1% vs. 36.6%).

Relationship between LQ-10 distribution and subject variables

In Table V are summarized distributions of subjects with particular characteristics in ten LQ classes.

Age

When grouping the subjects according to their age in two classes (10-18 years; 19-80 years) a significant relationship between age and LQ-10 (chi-square = 46.03; d.f.=9; $p<.001$) emerged indicating a greater number of right-handers in the older people.

Sex

There is no relationship between sex and LQ-10 distribution (chi-square = 6.1; d.f.=9; n.s.), also when subjects are grouped according to age (chi-square = 10.9; d.f.=9; n.s. in the younger group and chi-square = 1.6; d.f.=9; n.s. in the older group).

Familiarity

An item of the questionnaire required to indicate if any of the subject first-degree relative was a left-hander. On the basis of the answers given by subjects an analysis was carried out in order to investigate the relationship between LQ and the presence of familial sinistrality. Grouping subjects in

TABLE V

Distribution of Subjects with Particular Characteristics in Ten LQ Classes

Classes		1	2	3	4	5	6	7	8	9	10
Total	(1694)	43	18	20	9	22	56	117	285	343	781
Females	(733)	17	6	10	5	9	20	44	120	149	353
Males	(961)	26	12	10	4	13	36	73	165	194	428
FS+	(329)	14	6	8	4	4	11	36	56	68	122
FS−	(1365)	29	12	12	5	18	45	81	229	275	659
10-18 yr	(822)	22	10	14	6	11	31	57	153	203	315
19-80 yr	(872)	21	8	6	3	11	25	60	132	140	466

two classes: with no first-degree left-handed relative (FS−) and with at least one first degree left-handed relative (FS+), a significant relationship was present for LQ-10 (chi-square = 32.88; d.f.=9; $p < .01$). This relationship indicates that the presence of familial sinistrality increases the probability of being left-handed, 10.9% and 5.6% respectively. Considering right-handers only, LQ distribution in FS+ group and in FS− group are significantly different (chi-square =16.7; d.f.=4, $p < .01$) with a lower percentage of strongly (LQ > 80) right-handers in the FS+ group than in the FS− group (37 vs. 48%).

Familiarity and sex

Sex distribution in FS+ group and in FS− group are significantly different (chi-square = 34.87; d.f.=1; $p < .001$) indicating in the FS+ group a higher presence of females. Similar results were obtained by Briggs and Nebes (1975).

Crossed preference

The term crossed preference is usually used to refer to an opposite lateral preference for hand-eye or for hand-foot. To calculate crossed preference we considered only subjects with a rather definite lateral preference, that is subjects with LQ <= −50 and LQ >= + 50. Considering together the two groups of subjects, percentage of hand-eye crossed preference was 27.0% with 25.0% among subjects with LQ< − 50 and 27.0% among subjects with LQ> 50. Only 5.7% of subjects showed hand-foot crossed preference. Percentages calculated over the group with LQ < −50 and LQ > 50 were 12.9% and 5.2% respectively. Hand-eye crossed preferences are equally distributed in males and females (chi-square = 3.5; n.s.).

Given the particular relevance of the item "writing", crossed preference has been evaluated also with respect to writing. Results indicate that among left-handers (LQ =< −50) 12.7% use their right hand for writing, while no right-handers (LQ >= 50) uses the left hand.

Previous experience with the use of the left hand

An item of the questionnaire required the subjects to indicate if they had any previous experience with the use of the left hand. 17.1% of the subjects answered positively to this question showing no sex difference, and of these 40.6% (6.9% of the total number of subjects) stated that their hand preference had been corrected. However the claim of having been corrected for left preference does not influence the handedness distribution, that is, there is no significant difference between the distributions of the "corrected" group versus the "uncorrected" one, not even when the

distribution is based on the LQ-10E, where writing and drawing are included. Furthermore a previous experience in the left hand does not appear to be more frequent in subjects FS+ with respect to FS−.

DISCUSSION

It is commonly accepted that hand preference is best described by a continuous variable (Bradshaw and Nettleton, 1983; Bryden, 1982; Corballis, 1983). Assessment of hand preference by the use of a single item artificially groups people in a limited number of classes. In addition, as Table II shows, handedness distributions noticeably differ from item to item in a rather complex way. For instance a low percentage of left preference may be accompanied either by a high percentage of right preference (e.g. writing and drawing) or by a high percentage of either preference (e.g. comb and throwing). Probably these differences are originated by multiple causes among which are: differential cultural pressure to use the right hand in particular activities (writing, drawing, eating...), differential sensory motor load possibly related to different degrees of unilateral cerebral control, different amounts or kinds of practice. It follows that data on hand preference based on single questions are highly questionable.

On the other hand the use of a questionnaire composed of several items also poses problems, related to the number (Provins et al., 1982) and to the type of items to be included (Bryden, 1977). The non statistical difference between LQ-20 and LQ-10E distributions together with a significant difference between distributions obtained with an equal number of items (LQ-10E vs LQ-10) suggest that the kind of items selected can be more critical than their number in determining the distribution of subjects on the LQ continuum. Since the classification of subjects as right- and left-handers is made on the basis of LQ distribution, the comparison between studies using different questionnaires may be debatable.

In relation to the kind of activities to be included in a questionnaire, the first point that should be taken into account is that, as mentioned before, motor activities differ and in absence of some convincing criterion that indicates which activities should be preferentially considered as indicative of hand preference, a statistical procedure seemed most appropriate. Starting from the initial pool of items considered by Oldfield (1971) we selected on the basis of a statistical index, the activities whose lambda distribution more closely approximate the LQ distribution, and arbitrarily chosen the ten best items.

The most evident result of the item analysis is the exclusion of writing and drawing from the set of the "best" ten items. These two items are peculiar for several reason. (a) They strongly dichotomize the population (see Table II) and in this sense they do not well represent the phenomenon of handedness which is best described by a continuous variable. (b) They are the activities that are more subjected to cultural pressure (Levy, 1974; Levy, 1982; Teng et al., 1979) and more often exercised. (c) Writing hand often correlates poorly with other indices (Bakan, 1973; Bradshaw and Nettleton, 1983) and is the item of the questionnaire with the lowest correlation with EEG and dichotic measures (Davis and Wada, 1978; Johnstone, Galin and Herron, 1979; Subirana et al., 1959). (d) Many authors (Bradshaw and Nettleton, 1983; Bryden, 1982; Corballis, 1983) agree on the necessity to include in a questionnaire items that are the least subject to the effects of cultural pressure and practice. However, this consideration is not taken into account since both Bryden (1982) and Corballis (1983) adopt questionnaires in which "writing" and "drawing" are included. This inclusion is not without effect since, as shown in a previous paper (Salmaso and Longoni, 1983), there is a significant difference between the distributions with and without writing and drawing. Moreover comparing in our sample the two LQ distribution obtained with our selection and Bryden's selection [The items proposed by this author are writing, drawing, throwing, using scissors and toothbrush] a significant difference is obtained (chi-square $= 49.0$; d.f. $= 9$; $p < .001$). The exclusion of the item "broom " is in agreement with the rarity of this item in other questionnaires and with its poor reliability and validity (Rackzoviski et al., 1974). It is worth noting that this last item, together with rake, golf club and cricket bat, represent activities in which both hand are involved, and that different motor systems with different dominance (Geschwind, 1984) could be responsible of their control. Finally, we observe that the rank order 1 attributed to "throwing" is in agreement with Oldfield's observation that this item could be considered a good indicator of hand preference (Oldfield, 1971). Altogether the results of the item analysis provide a statistical support for all previous considerations. Therefore we decided to consider the new selection of items reported in Table III as the basis for determining LQ and for studying its relationship with subject variables.

In our sample percentage of left-handers resulted to be 6.6%. As it is apparent in Table I there is considerable variation in the incidence of left-handers in different samples probably explicable in terms of methodological differences among studies and cultural and biological differences among samples. However, these factors interact in a rather complex way in the reported studies and also if there are marked differences in the percentages of left-handers it is difficult to explain them in terms of the relative influence of one of the factors.

According to our study it seems that in Italy a pressure toward the use of the right hand was not uncommon since approximately 7% of our subjects reported to have been corrected in the tendency to use the left hand and also only in left-handers are present crossed preference for writing. An indication of the influence of cultural factors, can be obtained comparing, in different studies, left preference for "writing" and "drawing" with left preferences for activities presumably not susceptible to cultural pressure, like throwing. Left preference for writing or drawing are 9.4 in American adults (Peterson, 1979), 8.8 in British adults (Fleminger et al., 1977), 4.4% in our sample and 1% in Taiwan (Teng et al., 1979), indicating some differential influence of cultural factors on hand preference, while left preference for throwing are 4% (Teng et al., 1979) and 5.5% in our study.

A comparison of the LQ distribution in the positive axis with that of the negative axis shows that hand preference is more variable among left-handers than right-handers. This result often emerges in studies on handedness (Corballis, 1983) and parallels the more variable or less lateralization of language functions among left-handers in comparison with right-handers. It has been proposed that the heterogeneity among left-handers can be explained in terms of the existence of two groups of left-handers; one with history of familial sinistrality and one without. It has also been proposed that the two groups may differ for cerebral lateralization (Hécaen and Sauguet, 1971; Newcombe and Ratcliff, 1973; Zurif and Bryden, 1969).

A further indication of the difference between left and right-handers comes from cross-preference. In agreement with previous findings (Subirana, 1969) our results indicate that in left-handers hand-foot crossed preferences are more frequent than in right-handers. On the contrary our findings do not show any significant difference between left and right handers for hand-eye crossed preference at variance with other studies (Friedlander, 1971; Levy and Gur, 1980; Porac and Coren, 1976).

As it is well known hand preference distribution can be affected by some subject variables. It is commonly reported that there is a natural tendency to become more right-handed with age (Fleminger et al., 1977). This effect is also present in our results, being the percentage of right-handers 92.3% in the "young" group and 94.4% in the "old" group. This trend poses an interpretation problem: it could be due to a natural increasing towards right preference with age (a longitudinal study would be methodologically appropriate to demonstrate this) or it could reflect the different cultural conditions that groups of different age have experienced (Levy, 1974; Porac and Coren, 1981). Our data seem to be in favor of the natural tendency hypothesis, since the increasing of dextrality with age appears also when hand preference is assessed by means of a questionnaire without cultural items.

In agreement with previous findings our data show that the presence of

familial sinistrality not only increases the incidence of left-handers (Levy and Nagylaki, 1972; Shimizu and Endo, 1983) but also modify the LQ distribution of right-handers (Piazza, 1980; Zurif and Bryden, 1969). These data do not allow one to ascribe this effect either to a genetic or to environmental cause. We limit ourselves to the observation that a higher incidence of left-handers in the FS+ group is present even when two of the items that are more susceptibile to cultural pressure have been eliminated.

A final point that should be taken into account concern sex differences in handedness. Some studies find more left-handers in males than in females (e.g. Annett, 1972; Bryden, 1977; Oldfield, 1971; Porac and Coren, 1981; Shimizu and Endo, 1983) while others do not (e.g. Annett, 1967; Newcombe and Ratcliff, 1973; Searleman et al., 1979; Silverberg et al., 1979). Cultural differences among samples and/or difference among studies and a possible weakeness of this relationship could be responsibile for the variability of the reported findings.

In conclusion, different assessment methods give also different LQ distributions. It is therefore crucial to converge towards a widely accepted choice of items to be included in a hand preference questionnaire. We propose on the basis of an objective method a questionnaire characterized by a choice of items different from those proposed by other authors.

ABSTRACT

Hand preference for the original items proposed by Oldfield (1971) and information concerning age, sex, familial sinistrality were obtained from a population of 1694 subjects. An item analysis was performed which resulted in the elimination of some of the items. Handedness distribution derived on the basis of the selected items was compared with the distribution obtained on the basis of the Oldfield's selection. Results show that handedness distributions depend on item selection, familial sinistrality and age, while no effect of sex is found.

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