

The Dutch Handedness Questionnaire

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Handedness questionnaires typically include an item on preference for writing. However, because writing is influenced by cultural factors, this item was not included in the present 16-item Dutch-language questionnaire. The questionnaire was completed by 456 subjects. The item consistency of the 16 preference items was very high. Principal component analysis on the 16 items revealed one single handedness dimension. Preference for hammering showed the highest item-test correlation. The final version of the handedness inventory contains the ten items with the highest factor loadings.

Key Words: handedness; hand preference; sinistrality, ambidexterity; laterality; questionnaire; manual activities

Lateralization of brain function is essential to a broad range of neural and behavioral processes. In the investigation of brain lateralization, handedness is an important subject variable. Research evidence indicates that the patterns of cerebral organization found in left-handers are more heterogeneous than those found in right-handers (Bryden, 1987). Sodium amytal testing and aphasia data have revealed that about 96% of right-handers have speech mediated by their left hemisphere, and the remaining 4% have speech mediated by their right hemisphere. For left-handers a distribution is estimated with 60-70% of left-handers having left-hemisphere speech, 15-20% having right hemisphere-speech and 15-20% having bilateral speech representation (Rasmussen & Milner, 1977; Segalowitz & Bryden, 1983).

Two separate aspects of handedness can be discerned. These are proficiency and preference. Proficiency measures refer to the greater muscle-strength and skillfulness of one of the two hands. Muscle strength in each hand can be determined by a test of grip strength; skill of each hand can be assessed by having subjects perform motor tasks, such as finger tapping or Annett's (1985) pegboard task (manipulation of small parts). Preference measures refer to the hand chosen when only one hand is being used in the execution of a given manual activity.

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Preference can be assessed adequately by means of a self-assessment questionnaire in which a subject is asked to indicate which hand is used to throw a ball, to hold a hammer, to draw, and so on.

In general, this type of questionnaires is both reliable and valid (Bryden, 1987). Upon repeated testing, subjects give the same score; and the agreement between actual behavior and the claims on the questionnaire is very high. From the data of Raczkowski, Kalat, and Nebes (1974) 14 hand preference items can be selected, with test-retest agreements ranging from 89-100% and with test-actual behavior agreements of 93-100%. Employing an eight-item questionnaire, Porac and Coren (1978) found test-retest agreements (after 12 months) that ranged from 96-100%.

Neither strength nor skill shows strong concordance with preference. In general, the agreement between preference and proficiency measures equals 59% for grip strength, 74% for small parts manipulation, and 80% for tapping speed (Porac & Coren, 1981). Comparing proficiency and preference measures, Johnstone, Galin, and Herron (1979) concluded that the handedness questionnaire was the best general measure of handedness. Tapping speed, manipulation of small objects, and grip strength correlated better with the questionnaire than with each other. Compared to the proficiency measures, the questionnaire better related to asymmetry measures based on EEG and dichotic task results. Other studies also have reported low intercorrelations between various skill and strength measures (e.g. Fleischman & Ellison, 1962). As Porac and Coren have pointed out, the reason for this may be the multidimensional nature of these tasks. Factor analytic studies on proficiency measures have resulted in five to ten separable dimensions (e.g. Barnsley & Rabinovitch, 1970; Fleischman, 1972). Factors such as strength, speed, coordination, accuracy, and aiming have been found to influence proficiency.

On the other hand, intercorrelations between the items of preference questionnaires are generally very high. For instance, Roszkowski, Snelbecker, and Sacks (1981) assessed the item consistency of 15 preference items and found a Cronbach alpha coefficient that equalled .96. Consistent with this result, Roszkowski et al. reported that factor analysis revealed the presence of only a single dimension. A similar single dimension of handedness has been reported by McFarland and Anderson (1980) and by Richardson (1978).

To summarize, hand preference questionnaires are highly reliable and valid. Because these questionnaires appear to be unifactorial and to relate better to hemispheric laterality than do proficiency measures, the use of these questionnaires may be the most appropriate way to assess handedness.

The three best-known handedness inventories of the last four decades are those of Crovitz and Zener (1962), Annett (1970), and Oldfield (1971). The hand preference items used in these questionnaires, together with 14 selected items of the Raczkowski et al. study, are listed in Table 1. The Crovitz-Zener Questionnaire consists of 14 preference items, with 9 items referring to the preferred hand and the remaining 5 items referring to the nonpreferred hand. These 'reversed' items describe bimanual activities in which the nonpreferred hand is used to position an object in space while the preferred hand is used to manipulate that object. For instance, a right-hander will position a nail with his left hand when hitting it with the hammer in his right hand. It should be noted that the use of reversed items disrupts the homogeneity among the preference items;

the various items no longer measure one single underlying dimension. Bryden (1977) carried out a factor analysis on 984 completed Crovitz-Zener Questionnaires, and found, besides a handedness factor, a second factor on which the reversed items in particular loaded.

For the present research, a Dutch-language handedness questionnaire was compiled. A selection was made from the most reliable and valid preference items that have been reported for the inventories mentioned above. Two other, not previously used items were also included ("turning a key" and "unscrewing top"). Items of the Crovitz-Zener questionnaire that refer to the use of the nondominant hand were not selected. Items that were ambiguous (such as "top hand on broom") or that referred to gross movements (such as "using glass" and "carrying books") were not selected either. In this paper, the psychometric properties of the questionnaire will be presented.

Table 1: Items from Four Different Handedness Questionnaires.

Kalat (1974)	Crovitch and Zener (1962)	Annett (1967)	Oldfield (1971)	Raczkowski, and Nebes
Writing	x	x	x	x
Throwing	x	x	x	x
Holding toothbrush	x	x	x	x
Using scissors	x	x	x	x
Draw	x		x	x
Holding racket	x	x		x
Striking a match		x	x	x
Dealing cards		x		x
Holding hammer		x		x
Holding eraser				x
Using butte opener				x
Using screwdriver				x
Top hand on broom		x	x	
Treading needle		x		
Top hand on shovel		x		
Cutting with a knife	x		x	
Opening a box			x	
Pouring a pitcher	x			
Unscrewing jar lid		x		
Carrying books				x
Using a glass	x			
Using spoon			x	
Stirring				x
Reversed items:				
Holding a nail for hammering	x			
Holding a bottle to uncap it	x			
Holding a potato to peel it	x			
Holding a needle to thread it	x			
Holding a dish to wipe it	x			

METHOD

Self-assessment questionnaire

The self-assessment handedness questionnaire consisted of 16 hand preference items. The items are listed in table 2. For each activity in the questionnaire the subjects indicated whether the left or right hand was used or whether both hands were used.

Table 2: Items Contained in the Handedness Questionnaire.

Which hand do you use to hold scissors? (scissors)
With which hand do you draw? (draw)
With which hand do you screw the top off a bottle? (screw top)
With which hand do you deal cards? (deal cards)
Which hand do you use to hold a toothbrush when cleaning teeth? (toothbrush)
With which hand do you use a bottle opener? (bottle opener)
With which hand do you throw a ball away? (throwing)
Which hand do you use to hold a hammer? (hammer)
With which hand do you thread a needle? (thread needle)
With which hand do you hold a racket when playing tennis? (tennis racket)
With which hand do you open the lid of a smart box? (lid)
With which hand do you turn a key? (key)
With which hand do you cut a cord with a knife? (knife)
With which hand do you stir with a spoon? (stir)
With which hand do you use an eraser on paper? (eraser)
With which hand do you strike a match? (match)

They received the following written instruction:

"A number of activities, in which you can use either your left or your right hand, are specified below. Indicate which hand you usually use for these activities. Visualize the activity in question, if you are not immediately sure of an answer. If you don't have a clear preference, indicate that you use both hands."

Each item was coded from 0 to 2, with "left" receiving a score of 0 and "right" receiving a score of 2, and "both" receiving a score of 1. Therefore, the total score could range from 0 (i.e. extremely left-handed) to 32 (i.e. extremely right-handed). Subjects also had to indicate which hand they used for writing and to report whether they had been compelled to use the non-preferred hand for writing. Note that writing hand was not included as a preference item, because writing is thought to be more influenced by cultural factors than are any of the other manual activities.

Participants

Completed questionnaires were obtained from 456 persons (213 male, 243 female), mainly students as well as a number of university staff members, who had been recruited through university newspaper advertisements. In these advertisements, left-handers in particular were asked to participate. About 54% of both male and female respondents used their left hand for writing and about 46% used

their right hand. Ages ranged from 16 to 45 years, with a mean age of 24 years. Note that the present sample is not representative of the general population with respect to the prevalence of left-handedness. However, in a true population sample with a relatively small number of left-handers, scores would be extremely skewed to the right.

Table 3: Item-Rest Correlations.

Activity	Item-Rest Correlation
Hammer	.94
Stir	.93
Eraser	.93
Match	.93
Knife	.93
Toothbrush	.92
Bottle Opener	.92
Tennis Racket	.91
Draw	.89
Throwing	.88
Key	.85
Lid	.80
Deal Cards	.79
Thread Needle	.76
Scissors	.74
Screw Top	.72

RESULTS

Item analysis

Each handedness item was correlated with the total score minus the particular item (item-rest correlation). The item-rest correlation coefficients are presented in Table 3. The item that had the highest correlation with the total score was using a hammer, followed by stirring, erasing, striking a match, and cutting with a knife. The lowest correlations were found for dealing cards, threading a needle, holding scissors and unscrewing a top. The item consistency, as measured by Cronbach's homogeneity coefficient alpha, was very high: .98.

Principal component analysis

Because we selected items that supposedly measured a single dimension, we examined whether this was the case by means of a principal component analysis. One single factor was found, having an eigenvalue of 12.5 and accounting for 78.4% of the variance. The factor loadings and communalities of the 16 hand preference items on this factor are listed in Table 4.

Table 4: Factor loadings and Communalities on the Handedness Factor.

Activity	Loading	Communality
Hammer	.95	.90
Eraser	.95	.89
Stir	.94	.89
Match	.94	.89
Knife	.94	.88
Toothbrush	.94	.88
Bottle Opener	.93	.87
Tennis Racket	.92	.85
Draw	.91	.83
Throwing	.90	.81
Key	.87	.76
Lid	.82	.67
Deal Cards	.81	.66
Thread Needle	.79	.62
Scissors	.77	.60
Screw Top	.75	.56

Table 5: Percentage of Strongly Left-handed Subjects, Ambidexters and Strongly Right-handed Subjects Using Left Hand, Both Hands, or Right Hand for Each Activity.

Activity	Strongly Left-handed Subjects (n = 184)		
	Left	Both	Right
Writing	92.3	0.5	7.1
Scissors	82.6	2.7	14.7
Draw	96.7	1.1	2.2
Screw Top	91.8	3.8	4.3
Deal Cards	95.1	0.5	4.3
Toothbrush	95.1	3.8	1.1
Bottle Opener	98.9	0.5	0.5
Throwing	97.8	0.0	2.2
Hammer	100.0	0.0	0.0
Thread Needle	89.7	2.7	7.6
Tennis Racket	98.4	0.0	1.6
Lid	94.6	3.8	1.6
Key	90.8	6.5	2.7
Knife	98.9	0.5	0.5
Stir	96.2	3.3	0.5
Eraser	99.5	0.0	0.5
Match	99.5	0.0	0.5

Activity	Ambidexters (n = 101)		
	Left	Both	Right
Writing	73.0	0.0	27.0
Scissors	32.0	5.0	64.0
Draw	81.0	1.0	18.0
Screw Top	39.0	18.0	43.0
Deal Cards	53.0	7.0	40.0
Toothbrush	67.0	12.0	21.0
Bottle Opener	59.0	12.0	29.0
Throwing	54.0	3.0	43.0

Table 5 (continued)

Ambidexters			
Activity	Left	Both	Right

Hammer	63.0	7.0	30.0
Thread Needle	67.0	7.0	26.0
Tennis Racket	54.0	8.0	38.0
Lid	51.0	26.0	23.0
Key	30.0	30.0	40.0
Knife	60.0	5.0	35.0
Stir	61.0	18.0	21.0
Eraser	75.0	13.0	12.0
Match	60.0	13.0	27.0

Strongly Right-handed Subjects (n = 172)			
Activity	Left	Both	Right

Writing	1.2	0.6	98.2
Scissors	0.0	0.0	100.0
Draw	1.2	0.0	98.8
Screw Top	8.7	5.2	86.0
Deal Cards	2.3	2.3	95.3
Toothbrush	0.0	0.6	99.4
Bottle Opener	0.6	2.3	97.1
Throwing	0.0	0.6	99.4
Hammer	0.6	0.0	99.4
Thread Needle	6.4	2.9	90.7
Tennis Racket	0.0	0.0	100.0
Lid	2.9	15.7	81.4
Key	0.0	2.9	97.1
Knife	0.0	0.6	99.4
Stir	0.0	5.2	94.8
Eraser	0.6	1.2	98.3
Match	0.0	0.6	99.4

Given the single handedness dimension, it is no surprise that the results are highly similar to the outcomes of the item analysis. The highest loadings on the handedness factor were found for using a hammer, stirring, erasing, striking a match and cutting, with a knife.

Handedness groups

The use of a self-assessment hand preference questionnaire allows for the measurement of handedness along a continuum. Subjects who perform all activities with their left hand represent one end of the continuum, while subjects who perform all activities with the right hand represent the opposite end. A frequently used subdivision into three handedness groups is: (1) strongly left-handed subjects, (2) ambidexters, and (3) strongly right-handed subjects. In the present research, subjects are considered to be strongly left-handed if their total score on the questionnaire equalled four or less, or to be strongly right-handed if this score equalled 28 or more. Based on these criteria, our subjects were assigned to the three handedness groups. Subsequently, hand preferences for writing and the other activities listed in the questionnaire were examined in each group. The results are given in Table 5. As can be seen from this table, the vast majority of the strongly left- and right-handed subjects used their preferred hand for the listed activities. However a substantial part of the strongly left-handed subjects (15%) held scissors in the right hand. This may be due to the fact that scissors usually

are designed for right-handers. About 7% of the strongly left-handed subjects used their right hand for writing. It is remarkable that only 2% of the strongly left-handed subjects used their right hand for drawing. Apparently, a number of left-handers have been forced to use their right hand for writing but have been allowed to use their left hand for drawing.

The prevalence of individuals who reported to use both hands for a certain activity was larger in the group of ambidexters than in the two other groups. Yet, a large proportion of the ambidexters used either the left or the right hand for a particular activity. It therefore seems likely that persons with an ambiguous hand preference (i.e., persons who show no clear preference for a given hand on most of the tasks) accounted for only a minority of the group of ambidexters. In the group of ambidexters, 27% used the right hand for writing, while 18% used this hand for drawing. This result again demonstrates the cultural influence on the choice of the writing hand. Surprisingly, two strongly right-handed individuals used their left hand for writing and drawing.

CONCLUSIONS

Both the item-consistency measure and the principal component analysis clearly proved that the items of the questionnaire at issue assessed one single handedness dimension. Hammering and erasing were the items with the highest loadings on this handedness factor. Other studies also have found hammering to be the best single predictor of handedness (Annett, 1970; Roszkowski et al, 1981). Hammering demands exact motor control; each blow requires precise aiming, timing and modulation of force. Obviously, if one mishits a nail, the results can be disastrous. Most likely, the best strategy is to use the preferred hand for hammering and to never try the nonpreferred hand.

When asked, 8% of the respondents in the present sample indicated that in childhood they had been compelled to use the right hand for writing instead of the preferred left hand. The questionnaire data indicated that about 6% of the left-handers and ambidexters use the right hand for writing and the left hand for drawing. It is evident that for a number of left-handers the choice of writing hand has been influenced by culture. Therefore, it seems justified that in the present questionnaire writing is not included as a preference item.

For practical use, a shorter version of the handedness questionnaire can be constructed easily by selecting the 10 items with the highest factor loadings (See appendix 1 for the final 10-item Dutch-language version).

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APPENDIX – Dutch Handedness Inventory

Vragenlijst handvoorkeur

Met de onderstaande vragenlijst kunt u bepalen hoe uitgesproken links- of rechtshandig u bent.

De lijst bestaat uit één vraag over de hand waarmee u bij voorkeur schrijft en tien vragen met betrekking tot uw voorkeurshand voor andere handelingen. Geef voor elke vraag aan met welke hand u de betreffende handeling gewoonlijk uitvoert.

Schrijfhand

Omcirkel met welke hand u schrijft:

links rechts op school gedwongen rechts te schrijven

Handvoorkeur

Hieronder staat een aantal activiteiten die u met uw linker of rechterhand kunt uitvoeren. Omcirkel welke kant u gewoonlijk gebruikt voor elk van deze activiteiten. Indien u het antwoord niet meteen weet, voer dan de betreffende handeling in gedachten uit. Heeft u geen duidelijke voorkeur, omcirkel in dat geval 'beide'.

- | | |
|--|----------------------|
| 1. Met welke hand tekent u? | linker rechter beide |
| 2. Welke hand gebruikt u om met een tandenborstel te poetsen? | linker rechter beide |
| 3. In welke hand houdt u een flesopener vast? | linker rechter beide |
| 4. Met welke hand gooit u een bal ver weg? | linker rechter beide |
| 5. In welke hand heeft u een hamer vast als u ermee op een spijker moet slaan? | linker rechter beide |
| 6. Met welke hand houdt u een (tennis-)racket vast? | linker rechter beide |
| 7. Welke hand gebruikt u om met een mes een touw door te snijden? | linker rechter beide |
| 8. Welke hand gebruikt u om met een lepel te roeren? | linker rechter beide |
| 9. Welke hand gebruikt u om met een gummetje iets uit te vlakken? | linker rechter beide |
| 10. Met welke hand strijkt u een lucifer aan? | linker rechter beide |

Scoring

Om de totaalscore op de tien items te bepalen, geeft u het antwoord 'linker' de score -1, 'beide' de score 0 en 'rechter' de score +1. De score kan variëren van -10 voor extreme linkshandigheid tot +10 voor extreme rechtshandigheid. De schrijfhandoorkeur wordt niet in de totaalscore betrokken. De overgrote meerderheid van de rechtsschrijvers zal in de range van +8 tot +10 vallen.

Bron

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