

Handedness in Colombia: Some associated conditions

Alfredo Ardila

Instituto Colombiano de Neuropsicología, Bogotá, Colombia

Diego Rosselli

Clinical Epidemiology Unit, Universidad Javeriana, Bogotá, Colombia

GENECO

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As part of a national neuroepidemiological study a population-based sample of 6941 subjects, 10 years of age or older, was selected in five different regions in Colombia (South America). Overall, 91.65% of the participants (90.6% of the males; 92.7% of the females) considered themselves as right-handers. Handedness was significantly correlated with education in men but not in women. Handedness was not associated with age. Prevalence of history of loss of consciousness, tremors, difficulties with speech, and traumatic head injury was observed to be higher in non-handers than in right-handers. This finding was particularly evident in men. Implications of current results are analysed.

INTRODUCTION

The prevalence of left-handedness is generally considered to be around 5% to 12%, although the specific figure varies as a function of the source of the sample and the procedure for measuring handedness (Betancur, 1987; Bryden, 1982). Hécaen and Ajuriaguerra (1964) pointed out that estimates of the prevalence of left-handedness have ranged from 1% to 30%, with a median of about 7%. Annett (1973) reported a prevalence of 11.6% in England, while Bryden (1982) observed 10.4% of left-handedness in Canada. Hardyck, Goldman, and

Address correspondence to Alfredo Ardila, PhD, 12230 NW 8 Street, Miami, Florida 33182, USA.
Email: aardila@compuserve.com

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Petrovich (1975) reported a value of 9.9% among California school children. In the general population in the United States, however, it has been estimated that 10.5% of females and 13.0% of males write with the left hand (Gilbert & Wysocki, 1992).

Similar percentages have been observed in other countries. Reiss and Reiss (1997) reported a 91% prevalence of right-handedness in Germany. Silva-Rodriguez and Escobar-Izquierdo (1996) found a 6.75% prevalence of left-handedness among 300 university students in Mexico. Rosselli, Ramirez, and Zuñiga (1987) found a 9.5% prevalence of nonright-handedness using a sample of university students ($n = 2200$ subjects) taken in Bogotá (Colombia). A large survey administered to 12,000 subjects in 17 different countries reported prevalences of left-handedness ranging from 2.5% (Mexico) to 12.8% (Canada) (Perelle & Ehrman, 1994). Average percentages of left-handedness, right-handedness, and ambidexterity were 9.5%, 89.6%, and 0.9% respectively.

In non-Western societies the percentages of left-handedness have usually been reported to be lower. Hatta and Nakatusuka (1976) found 3.1% of left-handedness in Japan. Teng, Lee, Yang, and Chang (1976) found 1.5% of left-handedness among Taiwanese school children. In Korea, the prevalence of left-handedness has been estimated to be less than 1% (Kang & Harris, 1993). Interestingly, in Japan, the percentage of left-handedness may have been increasing recently. Hatta and Kawakami (1994, 1995) observed that non-right-handedness among male and female Japanese students numbered 11.5% and 5.9% respectively. This represented an increase in left-handedness, particularly in females, relative to the figures reported 20 years earlier. Iwasaki, Kaiho, and Iseki (1995), however, have not supported this finding. Using a Japanese sample of people aged from 10 to 70 years, they found that right-hand preference increased across age groups at least up to 30 years for men, while women showed a relatively stable and stronger preference for right-hand use.

There is some evidence for an association between handedness and sociocultural characteristics. Dawson (1977) reports around 10% of left-handedness in hunting and fishing societies (Alaskan Eskimo, Australian Arunta, Hong Kong boat people), compared to 1–3% among primitive agricultural societies, such as the Katanganese and the Temne of Serra Leona. Ardila et al. (1989) and Bryden, Ardila, and Ardila (1993) did not find any left-handed people among the Tucano natives from the Amazonian jungle, even though Tucano people carry out some daily activities with their left hand. Similar findings in other aboriginal people have been recently reported (Marchant, McGrew, & Eibl-Eibesfeldt, 1995).

Handedness may be associated with not only cultural but also genetic factors (Bryden, Roy, McManus, & Bulman-Fleming, 1997) and diverse genetic theories of handedness have been proposed (Annett, 1964, 1985; Levy & Nagylaki, 1972; McManus, 1985; Yeo & Gangestad, 1993).

Increased prevalence of left-handedness has been associated with several different pathological conditions (Betancur, 1987; Harris & Carlson, 1988) including mental retardation (e.g., Bradshaw-McAnulty, Hicks, & Kinsbourne, 1984), reading disability (e.g., Neils & Aram, 1986), epilepsy (e.g., Penfield & Roberts, 1959), alcohol abuse and smoking (e.g., Harburg, 1981; Harburg, Feldstein, & Papsdorf, 1978), allergies and autoimmune disorders (Coren, 1994; Geschwind & Behan 1982, psychosis (Lishman & McMeekan, 1976), increased injury risk (Wright, Williams, Currie, & Beattie, 1996), and even antisocial behaviour (Gabrielli & Mednick, 1980). A subgroup of left-handers, usually designated as ‘pathological left-handers’ has been proposed (Hécaen & Ajuriaguerra, 1964; Satz, 1972, 1973). In this subgroup, some abnormal early conditions associated with handedness are assumed (Coren, 1995a; Satz, Soper, & Orsini, 1988). This fact could explain why some pathologies (epilepsy, mental retardation, etc) may be over-represented in left-handers as a whole.

The purpose of this study was to measure the percentage of right and nonright-handedness in a large population-based sample in Colombia, and to analyse the relationship between handedness and some associated conditions.

METHOD

Procedure

During the years 1995–1996 the Colombian Association of Neurology carried out a large neuroepidemiological study (Rosselli et al., submitted). Urban populations of the five largest Colombian cities (Bogotá, 5.7 million; Medellín 2.6 million; Cali 1.8 million; Barranquilla, 1.4 million; and Bucaramanga, 0.8 million) and rural populations from small towns and countryside in their surrounding areas were included in the sample. These five regions contain about half of the 40 million Colombian inhabitants. In each of these regions, three different cluster samples were randomly selected: (1) one sample taken from the main urban centre, i.e., Bogotá, Medellín, Cali, Barranquilla, and Bucaramanga, randomly assigning neighbourhoods; (2) a second sample taken from a smaller town, randomly selected among all those located no more than two hours away from the main city; and (3) a rural sample taken from a different town also located no more than two hours away from the main city. For each one of the samples, the standard two-phase procedure used in neuroepidemiological studies with a modified version of the WHO research protocol for measuring the prevalence of neurological diseases in developing countries (Osuntokun et al., 1982) was used.

Participants

Using power analysis we estimated a sample size that could provide data on the nationwide prevalence of nine neurological disorders. The largest sample size estimated, reliable enough to be useful in those diseases with lowest prevalences

(i.e., Parkinson's disease, dementia, and head-injury-related disability) was 8720 subjects. Individuals 50 years of age or older were over-represented, in an attempt to improve detection of certain age-related disorders. Final sample size was 8910 subjects but only those 10 years of age or older ($n = 6941$) were used in the analysis of handedness.

Instruments

A modified version of the questionnaire developed by the World Health Organisation for the epidemiological study of neurological diseases was used (Glosser et al., 1993; Kapoor et al., 1990). The Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) was also administered to those participants over 50 years. In addition, one question about handedness was included ("Do you consider yourself right-handed, left-handed, or ambidextrous?"). Those participants with positive neurological symptoms; and/or with a MMSE below a cut-off score, were referred for a complete neurological exam.

RESULTS

Overall response rate was 85.7%. Women represented 61.3% of the sample. Table 1 presents the general distribution of the 6941 subjects according to age and gender. As expected, the percentage of left-handedness and ambidexterity was higher in males than in females. Right-handedness was 2.1 percentage points higher in women than in men.

There appeared to be no systematic trend over the different age groups, although it is perhaps worth noting that the oldest age group (>70) showed the lowest prevalence of right-handedness and the highest prevalence of ambidexterity.

TABLE 1
General distribution of the sample (4252 women, 2689 men) according to age and gender

Age	<i>Right-handers</i>		<i>Left-handers</i>		<i>Ambidextrous</i>	
	<i>Men</i>	<i>Women</i>	<i>Men</i>	<i>Women</i>	<i>Men</i>	<i>Women</i>
10-19 yrs	90.7	93.8	7.0	4.8	2.3	1.4
20-29 yrs	89.6	92.1	6.2	5.3	4.2	2.6
30-39 yrs	89.4	93.4	5.2	3.8	5.4	2.8
40-49 yrs	93.0	91.3	3.4	3.6	3.6	5.1
50-59 yrs	94.5	93.6	3.5	3.1	2.0	3.3
60-69 yrs	90.3	90.7	5.2	4.9	4.5	4.4
> 70 yrs	87.2	91.8	4.9	4.0	7.9	4.2
Average	90.6	92.7	5.0	4.2	4.4	3.1

The association between handedness and education was analysed (Table 2). In this and further analyses, left-handers and ambidextrous people were collapsed into a single group, and right-handers than compared with nonright-handers. Information regarding education was collected only in those subjects over 50 years, and in consequence in this analysis the sample size was smaller. In men, a steady but nonsignificant tendency towards increasing right-handedness with increasing education was observed, $\chi^2 (3, N = 590) = 1.72, p = .63$. In illiterates, the percentage of right-handedness was only 88.7% whereas in subjects with nine or more years of education it was 93.0%. In women, the opposite pattern was observed: right-handedness was negatively associated with the educational level, $\chi^2 (3, N = 952) = 2.83, p = .42$.

The association between handedness and some abnormal conditions was analysed. Self-reported loss of consciousness was more frequent in nonright-handers than in right-handers (Table 3). This association was statistically significant in men, $\chi^2 (1, N = 2689) = 10.89, p = .004$, but not in women, $\chi^2 (1, N = 4252) = 1.40, p = .497$.

By the same token, the question "Have you ever presented tremors in the hands or legs?" was more frequently answered in a positive way by nonright-handers than right-handers, both in males as in females (Table 4). In men, differences were close to a statistical level of significance, $\chi^2 (1, N = 2689) =$

TABLE 2
General distribution of the sample age 50+ (952 women, 590 men) according to educational level

<i>Education</i>	<i>Right-handers</i>		<i>Nonright-handers</i>		<i>Difference</i>
	<i>Men</i>	<i>Women</i>	<i>Men</i>	<i>Women</i>	
0 yrs	88.7	93.9	11.3	6.1	5.2
1-4 yrs	90.3	90.8	9.7	9.2	0.5
5-8 yrs	92.2	92.1	7.8	7.9	-0.1
>9 yrs	93.0	89.4	7.0	10.6	-3.6
Average	91.0	91.5	8.9	8.5	0.4

TABLE 3
Loss of consciousness ("Have you ever lost consciousness?")

<i>Frequency</i>	<i>Right-handers</i>		<i>Nonright-handers</i>	
	<i>Men</i>	<i>Women</i>	<i>Men</i>	<i>Women</i>
Never	82.00	80.0	73.5	77.8
Once	13.0	12.5	19.4	12.9
Several times	5.0	7.5	7.1	9.3

TABLE 4
Tremors in hands or legs ("Have you ever presented tremors in the hands or in the legs?")

Frequency	Right-handers		Nonright-handers	
	Men	Women	Men	Women
Never	88.7	86.2	83.7	85.1
Once	4.8	5.5	6.4	3.9
Several times	6.6	8.2	10.0	11.0

5.63, $p = .060$. In women, differences were not statistically significant, $\chi^2(1, N = 4252) = 4.06, p = .131$).

The positive answer to the questions "Have you ever found it difficult to speak or to say something?" was positively associated with nonright-handedness, particularly in men (Table 5). However, differences were not statistically significant either in men, $\chi^2(1, N = 2689) = 2.11, p = .348$, or in women, $\chi^2(1, N = 4252) = 0.63, p = .726$.

Finally, the association between handedness and a history of traumatic head injury was analysed (Table 6). This association was positive both in men and in women. However, only in men did differences reach a statistical level of significance, $\chi^2(1, N = 2689) = 4.03, p = .05$. In women, just a trend in this direction was found, $\chi^2(1, N = 4252) = 3.33, p = .068$.

TABLE 5
Difficulties with speech ("Have you ever found it difficult to speak or to say something?")

Frequency	Right-handers		Nonright-handers	
	Men	Women	Men	Women
Never	92.9	92.4	90.5	93.2
Once	3.1	3.4	4.4	2.6
Several times	4.0	4.2	5.2	4.2

TABLE 6
Head trauma with loss of consciousness ("Have you ever suffered a blow or hit on the head with loss of consciousness?")

Frequency	Right-handers		Nonright-handers	
	Men	Women	Men	Women
Yes	12.0	6.9	16.5	4.4
No	88.0	93.1	83.5	95.6

DISCUSSION

The use of a single question to determine handedness represents the main limitation of the current research. As mentioned earlier, handedness was determined within a rather extensive neuroepidemiological study, and in consequence, the number of questions had to be limited. Neuroepidemiological questionnaires primarily play the role of screening for neurological disorders. Despite this important limitation, there are several points in our results that should be highlighted.

Handedness was not associated with age. This result contradicts some previous reports. A very robust association between hand preference and age has been reported in the United States (Gilbert & Wysocki, 1992) and Canada (Coren, 1995b). However, this association has not always been supported in other countries, such as Japan (e.g., Iwasaki et al., 1995). No trend of increasing left-handedness was observed in our sample, despite the fact that a significant decline of cultural censorship against left-handedness has been observed in Colombia.

The difference in handedness between males and females, despite being statistically significant, was small. This gender difference is well known and has been extensively supported in diverse studies (Betancur, 1987; Bryden, 1982; Coren, 1995b).

The association between handedness and educational level has rarely been studied. Perelle and Ehrman (1994), in a large sample of 12,000 participants from 17 different countries, did not find significant differences relative to respondent's educational level, even though they observed differences in handedness related to type of primary school (public school, church school, private school). Lansky, Feinstein, and Peterson (1988), however, using a sample of 2083 subjects, found in females (but *not* in males) an association between handedness and educational level: compared to chance expectations, proportionally more left-handers reported having some college education or higher, whereas more right-handers reported having less education. A similar result is described by Stellman et al. (1997). We found the opposite association. In our sample, handedness was significantly associated with education in men, but not in women. In men, the percentage of right-handedness steadily increased with educational level. More left-handed and ambidextrous males were observed among illiterates than among educated subjects. In women, the relation was reversed: right-handedness decreases, but not in a systematic way, with the level of education. Furthermore, in illiterates, the percentage of nonright-handed men clearly outnumbered the percentage of nonright-handed women. This difference steadily decreased across the educational levels, and in the group with the highest education, the number of nonright-handed women clearly outnumbered the percentage of nonright-handed men. This association was rather unexpected.

Our sample was different from the one described by Lansky et al. (1988), or

Stellman et al. (1997), in many regards: the age distribution, the educational levels that were distinguished (our median level of education was considerably lower), the cultural background of the participants, and even the method used to determine handedness. These differences have to be considered when accounting for the association between educational level and handedness.

Different hypotheses could be proposed to explain the association that we observed between education and handedness: (1) It has been reported that literacy increases cerebral asymmetry for language (Lecours et al., 1987, 1988; Matute, 1988). A more bilateral representation of language would be expected in illiterates, eventually associated with a higher ambidexterity. (2) School failure is higher in left-handers as a result of the diverse abnormal conditions left-handedness may be associated with; in consequence, there is an increasing number of right-handers in higher educational groups. (3) Attending school results in a significant social pressure to use the right hand, not only in writing but also in other activities. It is not easy, however, to explain why these effects were opposite in males and females. Interestingly, a different effect of education on handedness for males and females was observed by Lansky et al. (1988) and Stellman et al. (1997).

Nonetheless, taking into consideration that these results refer only to subjects over the age of 50, certain observations should be taken into account: (1) even though nowadays social pressure for using the right hand may be nonsignificant, school pressure to use the right hand in writing was probably strong four or more decades ago; and (2) in older people, a higher educational attendance was expected in men than in women. At the beginning of the twentieth century very few women completed high school, and college was almost exclusively directed to males. It may be conjectured that only gifted girls, or some girls under certain very special circumstances, could remain at school. In consequence, very likely the male and the female samples were not equivalent with regard to the intelligence factor, and maybe some other extraneous variables. In any event, it is not easy to understand why the gender effect was opposite in men and women.

Handedness was significantly associated with some conditions, potentially correlated with some central nervous system dysfunction or pathology: loss of consciousness, tremors, difficulties with speech, and traumatic head-injury history. This observation supports the association between left-handedness with quite different pathological conditions (mental retardation, learning disabilities, epilepsy, etc.).

Evidently, the factors influencing handedness are quite a complex phenomenon. Doubtless, the cross-cultural studies of handedness and the analysis of associated conditions will significantly increase our understanding of these factors.

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