

## NOTE

# HANDEDNESS IS NOT RELATED TO SELF-REPORTED DISEASE INCIDENCE

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Geschwind and Behan (1982) reported the very provocative finding of an association of autoimmune disorders with left-handedness. In two surveys carried out in London and Glasgow, they found that strongly left-handed individuals and their first- and second-degree relatives were more likely to suffer from various immune disorders than strongly right-handed people and their relatives. In addition, left-handers also reported a higher incidence of learning disorders such as developmental dyslexia and stuttering. In this survey, immune disorders included such disorders as celiac disease, dermatomyositis, diabetes, Hashimoto's thyroiditis, myxedema, Crohn's disease, rheumatoid arthritis, thyrotoxicosis, ulcerative colitis, and uveitis. In a second study reported in the same paper, they found a greater incidence of left-handed in patient populations with severe migraine or myasthenia gravis, but not in patients with rheumatoid arthritis, multiple sclerosis, or mixed-collagen vascular diseases.

In a subsequent study, the same authors (Geschwind and Behan, 1984) reported higher incidence of migraine, allergies, dyslexia, stuttering, skeletal malformations, and thyroid disorders in left-handers. They also found an elevated incidence of left-handedness in patients with Crohn's disease, celiac disease, thyroid disorders, ulcerative colitis, and myasthenia gravis. Geschwind and Galaburda (1985a, 1985b, 1985c, 1987) have based an imaginative theory of the development of cerebral dominance on these data. In rudimentary form, they propose that elevated levels of fetal testosterone leads to retardation of immune development (and consequently various immune disorders) and to delayed growth of the posterior left hemisphere (thereby resulting in both left-handedness and various developmental learning disorders).

Studies intended to replicate these findings have used a variety of different approaches and have produced mixed results. Several authors have carried out large-scale surveys of unselected samples, often using undergraduate classes (e.g., McKeever and Rich, 1990; Van Strien, Bouma and Bakker, 1987). Using such an approach, van Strein et al. (1987) found no increase in allergies, migraine, or various autoimmune diseases among left-handers in a large Dutch sample. Likewise, Bishop (1986) found no increase in the incidence of allergies, eczema, psoriasis, or asthma in a very large sample unselected for educational level. While McKeever and Rich (1990) found very few significant effects in their study of undergraduate students, their data indicated a slightly elevated incidence of left-handedness in women who had been treated for immune disorders. Since the Geschwind argument (Geschwind and Galaburda, 1987) relates handedness to immune disorders through an elevation of fetal testosterone, the fact that the McKeever and Rich (1990) effects are confined to women provides evidence against the details of the Geschwind hypothesis. Smith, Meyers and Klein (1989) reported that left-handers were more likely to report asthma, but not eczema, migraine, or allergies. Burke, Yeo, Vranes et al. (1988) found relations between developmental language disabilities and both handedness and immune disorders, but no relation between the two latter variables.

Other researchers have selected medical samples of people with specific diseases, and compared these to control subjects. Such an approach, of course, is limited by the adequacy

of the control sample employed. For instance, Smith (1987) found a higher incidence of left-handedness in patients at an allergy clinic. The incidence of left-handedness in patients with eczema or urticaria, or with IgE-mediated allergies, was particularly high. Betancur, Vélez, Cabanieu et al. (1990), on the other hand, found no overall association between handedness and allergies, although they did report that the incidence of left-handedness was elevated in those whose allergic symptoms appeared prior to puberty.

Searleman and Fugagli (1987) found an increased incidence of left-handedness among patients with ulcerative colitis or Crohn's disease, although such an effect was not observed by Meyers and Janowitz (1985). No increased incidence of left-handedness in patients with systemic lupus erythematosus was found in one study (Schur, 1986), but others have found evidence for increased left-handedness (Chavance et al., 1990; Lahita, 1988).

Finally, Searleman and Fugagli (1987) have suggested a possible sex-dependency, in that males with type 1 diabetes (insulin-dependent) were more likely to be left-handed than those with type 2 diabetes (noninsulin-dependent), while the same did not hold for females. Chavance et al. (1990), however, found no effect of type 1 diabetes on handedness, although they did not examine sex effects carefully. Insignificantly fewer left-handers were found among patients with myasthenia gravis (Cosi, Citterio and Pasquino, 1988). The lower incidence of left-handedness in myasthenia has recently been replicated by McManus, Naylor and Booker (1990), lending credence to the view that the effect is a reliable one.

The Geschwind hypothesis (Geschwind and Galaburda, 1987) also suggests the relation between immune disorders and handedness might be stronger in intellectually gifted individuals. Consistent with this notion, Benbow (1986) has reported an elevated incidence of allergies and myopia in precociously verbal or mathematical children. On the other hand, Temple (1990) did not find any clear relationship between handedness and hay fever, migraine, or allergies amongst Oxford University faculty.

Although the Geschwind hypothesis (Geschwind and Galaburda, 1985a, 1985b, 1985c, 1987) has been a very attractive one, the support provided in the studies cited above has been far from unequivocal. Some of the problem may arise from the method of subject selection. Some studies select patients suffering from specified diseases and compare the incidence of left-handedness in that group to that observed in a putative control group (e.g., Cosi et al., 1988; Searleman and Fugagli, 1987). Since the control samples are usually relatively small, this opens the possibility of fairly large sampling errors in the incidence of left-handedness (even a sample of 225 has a standard error of about 2%). Others have studied a large unselected sample and looked for differences in the incidence of various diseases in left-handers and right-handers (e.g., Bishop, 1986; Van Strien et al., 1987). Most such studies have used self-report of disease incidence, rather than medical diagnosis, and have often used rather crude measures of handedness. Thus both approaches are open to criticism.

The present investigation involves a detailed measurement of handedness in a large undergraduate population. As such, it permits us to ask not only about the direction of hand preference, but also about the degree of hand preference. Furthermore, the study also makes it possible to consider various definitions of handedness in the same population. The existing studies have employed diverse measures of handedness, varying from a simple definition in terms of writing hand (Bishop, 1986) to the use of established hand questionnaires such as the Edinburgh Handedness Inventory (Oldfield, 1971). In some cases, the groups have been divided into right-handers and left-handers, but in others degree and direction of hand preference have been confounded by classifying those who sometimes use the left hand for certain activities as "non-right-handers" (e.g., Geschwind and Behan, 1984). Although there are numerous advantages to the present study in terms of the handedness measures available, it does depend on self-report of disease incidence, rather than on formal medical diagnosis, since it was part of a series of undergraduate surveys.

## MATERIALS AND METHOD

### *Subjects*

The subjects in the present study were 743 undergraduate students at the University of Waterloo, enrolled in introductory courses in psychology and kinesiology. Of these subjects,

303 were men, 434 were women, and 6 failed to answer the question about gender. They were given the handedness inventory and disease questionnaire in class, as voluntary participants.

### *Tests and Procedure*

The handedness inventory was a preliminary version of that developed by Steenhuis and Bryden (1989), with 25 items. In a factor analysis of hand preference questionnaires, Steenhuis and Bryden found two major factors, one of which was related to skilled unimanual activities such as writing and throwing, and the other of which was related to less skilled or practiced activities, such as picking up small objects. Eight items on the present inventory assessed skilled activities and 5 items assessed unskilled activities. In addition, on this particular questionnaire, five items concerned foot preference. Subjects were also asked if they considered themselves to be either left-handed or ambidextrous.

Subjects indicated their manual preferences on a 5-point scale: always use left (or right) hand; usually use left (or right) hand; use both hand equally. Scoring ranged from -2 for "always left" to +2 for "always right".

Four separate scores were derived from the questionnaire data. One was the average score on the 8 skilled activity questions — those questions that loaded on Steenhuis and Bryden's (1989) Factor 1, and a second was the average score on the 5 unskilled activity questions (Steenhuis and Bryden's, 1989, factor 2). A third score was the mean score on the 5 foot items, and a fourth the mean score on all 20 handedness items. Finally, a general laterality index was computed, using all 25 items.

Because Steenhuis and Bryden (1989) showed that their Factor 1 items (skilled activities) conform to what is usually meant by handedness, scores on the Factor 1 items were used to classify people as right-handed or left-handed (classification by questionnaire). Secondly, since the questionnaire asked each person to classify themselves as right-handed, left-handed, or ambidextrous, these data were also used to group the subjects (handedness by self-classification). Finally, subjects were also divided into right- and left-handed by writing hand, since this is often the only index of handedness available (classification by writing hand).

The disease questionnaire was derived from those employed by Geschwind and Behan (1982, 1984) and Benbow (1986). Subjects were asked whether or not they had, either now or previously, suffered from asthma, hay fever, eczema, drug or food allergies, rheumatoid arthritis, migraine, or persistent headaches. Subjects simply indicated the presence or absence of these diseases.

## RESULTS

One of the problems in relating various disorders to handedness is that handedness can be defined in many ways. We chose to examine three different definitions of handedness. First, we classified people by self-professed handedness. By this method, there were 637 right-handers, 72 left-handers, and 32 ambidexters. Second, we classified people by writing hand: 668 wrote with the right hand and 75 with the left hand. Finally, we classified people by their mean score on the 8 skilled hand questions. Subjects were considered to be right handed if their mean was positive, and left-handed if their mean was negative. By this classification, 672 were right-handed and 70 were left-handed. Note that the totals for the three classification schemes differ slightly: one subject obtained a mean item score of zero on the preference inventory, and two subjects failed to indicate their self-classification of handedness.

Tables I and II indicate the relative incidence of the various diseases as a function of handedness. Chi-square tests indicated that there were no statistically significant differences in the incidence of any of the reported diseases as a function of handedness, regardless of how handedness was determined. The only value that even approached significance at the nominal alpha level of .05 was for food allergies when handedness was determined by questionnaire ( $\chi^2 = 3.26, p < .07$ ). As can be seen in Table II, food allergies are somewhat less common in left-handers than in right-handers. Correcting the nominal significance level for the eight separate diseases which have been tested would require, by a Bonferroni correction,

TABLE I  
Disease Incidence as Related to Self-Reported Handedness

	Handedness			chi <sup>2</sup> (2 d.f.)
	Left N = 72	Ambi N = 32	Right N = 637	
Asthma	6.9%	6%	5.7%	0.21
Hay fever	26.4	21.9	22.4	0.59
Eczema	6.9	9.4	6.6	0.38
Any of above 3	33.3	34.4	29.4	0.80
Food allergies	4.2	12.5	8.9	2.51
Drug allergies	12.5	18.8	12.9	0.95
Any allergies	13.3 <sup>a</sup>	21.9	18.8	1.31
Rheumatoid arthritis	1.4	3.1	2.0	0.34
Migraine	9.7	9.4	7.4	0.63
Persistent headache	12.5	3.1	10.5	2.18

Note: All chi<sup>2</sup> values  $p > .5$ .

TABLE II  
Disease Incidence as Related to Handedness

	Handedness determined			
	By questionnaire		By writing hand	
	Left N = 70	Right N = 67 <sup>a</sup>	Left N = 75	Right N = 668
Asthma	7.14%	5.4%	8.00%	5.54%
Hay fever	25.71	24.7	25.33	22.45
Eczema	5.71	6.85	6.67	6.74
Any of above 3	34.29	29.46	33.33	29.49
Drug allergies	10.00	13.39	12.00	13.17
Food allergies	2.86	9.23	4.00	9.13
Any allergies	11.4 <sup>a</sup>	19.20	13.33	19.01
Rheumatoid arthritis	1.43	2.08	2.67	1.95
Migraine	10.00	7.59	10.67	7.49
Persistent headache	11.43	10.27	12.00	10.18

Note: The largest chi<sup>2</sup> val(1 d.f.) in this table is 3.26 ( $p < .07$ ) for the presence of food allergies when classification is by questionnaire. This would indicate a lower incidence of food allergies in left-handers. No other values exceed  $p < .05$ .

a nominal significance level of  $.05/8 \approx .00625$  in order to give a studywise alpha of .05; thus this one borderline effect does not begin to approach true significance.

One should note, however, that there are differences between men and women in the incidence of various diseases. In the present sample, for example, men were more likely than women to report that they were asthmatic, while women were more likely to report migraine, persistent headaches, and rheumatoid arthritis.

Because of these differences, we examined the association between handedness and disease for each sex separately. Because we were comparing handedness in eight diseases and two sexes, we set our minimal alpha level at  $.05/16 \approx .003125$  in order to keep the studywise alpha level at .05. Using this criterion, no associations between handedness and disease were significant within sexes.

In the final part of the analysis we asked whether there was any evidence that people reporting these diseases were different in their degree of laterality within handedness groups.

The Geschwind hypothesis (Geschwind and Galaburda, 1987) implies that afflicted right-handers will be less right-handed than non-afflicted right-handers, because the afflicted individuals should be more likely to show signs of "anomalous dominance". The hypothesis also suggests that afflicted left-handers should be more left-handed than non-afflicted left-handers, on the grounds that the more signs of "anomalous dominance" one has, the more likely the immune system is to be affected.

To examine this hypothesis, the mean item score for several measures from the hand preference inventory was determined. On the basis of the Steenhuis and Bryden (1989) paper, separate scores were derived for the skilled hand items and for the unskilled hand items for all subjects. In addition, scores were determined for the foot items, the total for all the handedness items regardless of factor type, and for the total lateral preference on the questionnaire. For each of these five variables, the scores of those afflicted with each disease was compared with those not afflicted with the disease within the right-handed groups as defined by each of the three methods of classification. If there was some evidence of an effect in the right-handers, where the samples were large, then the left-handed and ambidextrous groups were examined. The mean scores for left and right handers, classified by questionnaire, on Steenhuis and Bryden's (1989) skilled (Factor 1) and unskilled (Factor 2) handedness items are shown in Table III.

There are 64 separate comparisons in Table III, and therefore in order to keep the studywise alpha level at .05, results were only considered significant if they achieved a nominal level of  $.05/64 \approx .001$ . By this criterion, the only significant difference was that among men only, right-handers with persistent headache were more right-handed when either writing hand ( $t = 5.40$ , d.f. = 268,  $p < .001$ ) or self-professed handedness ( $t = 13.82$ , d.f. = 252,  $p < .001$ ) was used to classify the groups.

TABLE III  
*Degree of Handedness as Related to Disease Incidence*

	Skilled hand items		Unskilled hand items	
	With disease	Without disease	With disease	Without disease
Right-handers by Questionnaire N = 672				
Asthma	1.80	1.86	0.83	0.83
Hay fever	1.82	1.87	0.83	0.83
Eczema	1.90	1.85	0.79	0.83
Drug allergies	1.79*	1.87	0.73	0.84
Food allergies	1.83	1.86	0.76	0.83
Rheumatoid arthritis	1.80	1.86	0.83	0.83
Migraine	1.77*	1.86	0.69*	0.84
Persistent headache	1.85	1.86	0.73	0.84
Left-handers by Questionnaire N = 70				
Asthma	-1.03	-1.48	-0.24	-0.57
Hay fever	-1.46	-1.44	-0.49	-0.57
Eczema	-1.50	-1.44	-0.10	-0.58
Drug allergies	-1.57	-1.43	-0.63	-0.56
Food allergies	-1.88	-1.43	-0.60	-0.55
Rheumatoid arthritis	-2.00	-1.44	-0.20	-0.54
Migraine	-1.32	-1.46	-0.77	-0.52
Persistent headache	-1.38	-1.45	-0.75	-0.52

\*  $p < .05$ .

## DISCUSSION

Remarkably little support for the Geschwind and Galaburda (1987) hypothesis linking handedness and immune disorders has been found in this study. Furthermore, this lack of relationship is evident no matter how handedness is assessed. When the incidence of various diseases in right-handers and left-handers is compared, the only significant effect is that right-handed men with persistent headaches were more strongly right-handed than those who did not report such headaches. This effect is based on only 10 affected individuals, and may well be a consequence of high variance in the afflicted group.

Chavance et al. (1990) have argued that right-handers are less likely than left-handers to report that they have suffered from a given disease. They base their argument on the observation that left-handedness is elevated in their control subjects who reported some evidence for migraine, diabetes, or allergies, and data suggesting that disorders are overreported in interviews (Fienberg, Loftus and Tanur, 1985). However, by showing a difference between these "dubious controls" and those who did not report such disorders, they may actually be providing support for a relationship between handedness and certain diseases. Although the effects in their study are not statistically significant, it should be noted that their control subjects who reported migraine, diabetes, urticaria, asthma, and childhood eczema all scored substantially higher (more left-handed) on their preference questionnaire.

Taken together with other research on handedness and immune diseases, the present data provide virtually no support for the Geschwind hypothesis (Geschwind and Galaburda, 1987), since almost none of the associations are significant at a studywise level. Nevertheless, we feel that it is important to present these data. Undoubtedly, many people have examined the relation between immune disease and handedness in one way or another since the publication of the Geschwind papers. Those who have found positive relations are far more likely to make their data public, yet the negative findings are as important as the positive ones if one is to avoid the "file drawer" problem (Rosenthal, 1984).

## ABSTRACT

A hand preference inventory and a disease questionnaire were administered to a sample of 743 undergraduate students. The incidence of left-handedness was not related to the report of any of the diseases surveyed. Among right-handers, preference scores were slightly lower (less right-handed) in those reporting drug allergies or migraine. These data provide no support for the argument that handedness and immune disorders are related.

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