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Illness and Accidental Injury in Young and Older Adult Left- and Right-handers: Implications for Genetic Theories of Hand Preference

Clare Porac, Ingrid C. Friesen, Maria P. Barnes, and Vincenza Gruppuso

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Three age groups (N = 387) of self-classified left- and right-handers—young adults (ages 18 to 30 years), older adults (ages 55 to 74 years) and oldest old adults (ages 75 to 94 years)—answered questions concerning their health and accident occurrence history. We found no evidence to support the suggestion that left-handers were more likely to suffer from either major or minor health problems, including categories of illnesses associated with immune disorders. Also, the left-handed groups did not display a significantly higher incidence of either major or minor accidental injury, although they indicated that they found common cutting implements less easy to use when compared to the responses of right-handers. Left-handed participants in all 3 age groups indicated that attempts had been made, typically during their childhood years, to switch their hand preference toward the right side; the highest incidence rate of switch reports was among the oldest old adult left-handers, with 82.6% reporting hand preference change attempts. Our data are not consistent with models of hand preference formation that state that deviations from genetic right-hand preference are the complete or partial result of pathological influences (Coren, 1995b). However, our data can be incorporated into genetic models that take into account the influences of life experience variables on hand preference formation (Laland, Kumm, Van Horn, & Feldman, 1995).

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Researchers in the 20th century have produced enormous amounts of data about what must be one of the most widely studied aspects of human motor performance, namely, the consistent use of one hand while performing everyday unimanual actions. However, there are still many unanswered questions about factors that affect the development and subsequent behavioral manifestations of right-versus left-hand preference. It is interesting that the last 10 years of human hand preference research offer some of the most remarkable assertions about differences between right- and left-handers. New theories of hand preference origin have been proposed, and established theories have been refined in the face of new data (Annett, 1995; Corballis, 1996; Coren, 1994, 1995b; Laland, Kumm, Van Horn, & Feldman, 1995). Vigorous debate in the scholarly literature and widespread media attention in the popular press also have raised the awareness of a number of issues related to types of human hand preference and the behavioral and psychological implications possibly correlated with these types. The essential problem about postulating formative mechanisms for human hand preference is to account for the persistent presence of a left-handed minority in the face of the human population asymmetry toward right-hand preference (Harris, 1990). A recent large international study reported that the incidence of left-hand preference among adults is approximately 10%, when both side and consistency of preference are taken into account (Perelle & Ehrman, 1994). This 90% right versus 10% left incidence rate has remained relatively constant over the last 90 years, as revealed by an analysis of published reports (Porac & Coren, 1981).

Two established genetic theories of hand preference (Annett, 1985, 1994; McManus, 1985) attempted to deal in similar ways with the issue of the disproportionate incidence rate of human right- and left-hand preference. Annett (1985) argued that humans inherit a gene (rs+) that shifts hand laterality toward the right; if an individual does not bear the rs++ genotype, then chance factors play an increased role in determining the side of hand preference for rs+- and rs-- genotypes. Thus, any forms of non-right-handedness could be explained by various forms of physiological and environmental intervention. McManus (1985) stated that hand preference direction is under genetic control, and left-hand preference arises when an individual does not bear the dextral gene; hand preference is then determined by chance factors.

Two more recent genetic models promoted a specific role for nongenetic influences in the determination of hand preference side, over and above that attributed to chance. Laland et al. (1995) maintained that genetic variation does not underlie human hand preference; rather, natural selection has distorted the probability that humans will display right-hand preference to a level higher than chance (50%). This model places importance on environmental, especially parental, factors in determining variations in human hand preference. Coren (1994, 1995b) proposed that right-hand preference is a genetically determined species-specific trait, but that left-hand preference can be accounted for by two processes: One process is genetic
determination, and the other is pathological intervention that shifts the normal right-sided manifestation to the left side. Coren (1995b) implicated particularly the role of birth stress factors in causing shifts from natural right-hand preference. Coren and Searleman (1990) presented a model that claimed that any type of pathological intervention may cause a sidedness shift, from left to right or right to left. Because left-hand preference has a relatively low incidence rate among human populations, the Coren and Searleman model predicted that as many as 50% of a population of left-handers could display this trait as the result of a pathological sidedness switch. Attempts to account for the left-handed minority presence in human populations take the general form of postulating the operation of either unspecified chance factors (Annett, 1985, 1994; McManus, 1985) or the involvement of specific benign (Laland et al., 1995) or pathological (Coren, 1994, 1995b) interventions that move manifest hand preference away from genetic dextrality.

The pathological left-handedness model has prompted research into the specific connection between hand preference types and illness and accident risk. In its most recent form, called the elimination hypothesis, a term introduced by Hugdahl, Satz, Mitrushina, and Miller (1993), it is argued that the pathological influences that shift manifest laterality toward the left side also promote an increased susceptibility to disease and illness. For example, in their discussion of the atypical normal syndrome, Coren and Halpern (1991) stated that the presence of left-hand preference in an individual is a marker for covert neuropathology that could lead to problems, such as susceptibility to disease, which subsequently would affect the survival fitness of a left-handed individual. Coren (1989, 1992) argued further that left-handers were at greater risk for suffering accidental injury because of the influence of the right-handed majority in designing tools and other devices that favor right-hand over left-hand use. In some instances, such as in the manipulation of most common cutting and slicing devices, left-hand use is awkward and, perhaps, dangerous. The combined effects of susceptibility to illness and accidental injury place left-handers at a survival disadvantage (Coren & Halpern, 1991; Halpern & Coren, 1988, 1990, 1993). The low incidence rate of manifest left-handedness among older adults as compared to young adults, when large cross-sectional samples of individuals of different ages are measured on hand preference, is used frequently as evidence for the reduced life expectancy associated with left-handedness (Coren, 1992).

There is continued interest in the relation between hand preference and mortality risk factors. However, the typical methodology—where incidence rates of various ailments or accident occurrences are tabulated and compared in large cross-sectional samples of right- versus left-handers—is not a useful paradigm for understanding the relation between these variables (Porac, 1994). Therefore, our research explored the relation between hand preference and mortality risk factors in the context of an in-depth examination of young and older adult right-and left-handers,
with a special interest in gathering information about oldest old adults, those over the age of 75 years.

METHOD

Participants

Right- and left-handed adults, age 55 and older, were recruited through advertisements placed in newspapers and in community centers in Victoria, British Columbia, Canada, or in the surrounding vicinity, between 1993 and 1996. The older adult participants were paid a small honorarium. The young adult participants, ages 18 to 30 years, were recruited at the same time and were students at the University of Victoria or were members of the immediate community. They were given either course credit in introductory psychology or were paid a small honorarium for their participation.

One of the goals of our research effort was to seek actively for older adult left-handers who would then be matched to age cohort right-handers and groups of young adult right- and left-handers. Therefore, the final sample included 407 individuals, ages 18 to 94 years, of whom 387 (147 men and 240 women) had complete data. The sample was divided into three age groups: (a) Young adults (18–30 years of age; \( M = 21.9 \) years, \( SD = 3.3 \) years; 96 right-handers and 107 left-handers); (b) Older adults (55–74 years of age; \( M = 67.2 \) yrs, \( SD = 4.5 \) yrs; 51 right-handers and 91 left-handers); and (c) Oldest old adults (75–94 years of age; \( M = 80.9 \) yrs, \( SD = 5.4 \) yrs; 19 right-handers and 23 left-handers). Because of our intent to recruit left-handed participants, this sample included a relatively large percentage of left-handed adults (57%) and, therefore, was not representative of the incidence of left-hand preference in the general population.

Procedure

All participants were interviewed individually and responded to items on an 11-page inventory; the questions were asked by the experimenter. Questions concerning hand preference switch attempts and health and accident profiles were part of the interview schedule in addition to the assessment of hand preference behaviors. Hand preference was measured in two ways. First, individuals were coded as self-classified right- or left-handers depending on the advertisement that prompted their offer to participate. Second, each participant completed a 20-item inventory of everyday hand use behaviors, which included skilled (“With which hand do you write?”) and unskilled (“With which hand do you pick up a glass of water?”) items as classified by Steenhuis and Bryden (1989). Participants rated the
strength and side of each hand preference behavior on a 5-point scale, with the following indications: 1 (always use the right hand), 2 (prefer the right but sometimes use the left hand), 3 (use either hand), 4 (prefer the left but sometimes use the right hand), and 5 (always use the left hand).

The assessment of health history included questions concerning the occurrence of serious chronic illnesses, such as heart disease, as well as questions about the individual's current state of wellness. These latter items assessed the number of physician visits or days bedridden with an acute illness in the 12 months prior to the interview. Accident profiles contained questions on the ease of use of everyday tools and implements, such as knives and scissors. Participants rated the degree of difficulty experienced in using these implements on a 4-point scale, ranging from 1 (very easy) to 4 (very difficult); participants also indicated whether they had suffered a hand injury using such implements. The inventory also included questions about an individual's history of more serious vehicle and work-related accident occurrences. These latter questions asked participants to report on recent and past accidents during their adult lifetime.

RESULTS

Detailed analyses of the classification concordance between the 20 hand preference items and each individual's self-classification of hand preference indicated that specific items differed in their agreement with the self-classification of left-hand preference. We also found age differences in classification consistency. For example, the writing hand question showed a greater than 90% classification agreement with self-identified left-hand preference for the 18- to 30-year-old age group; however, among the oldest old left-handed adults, only 44% indicated that they wrote with their left hand (Porac, 1996b). There were no analogous problems associated with the classification concordance of right-handers. Therefore, we used the self-classification of side of hand preference to identify right- and left-handers.1

1The classification agreement between self-identified left-hand preference and specific preference items differed for the three age groups in the sample. Porac (1996b) showed that self-classification of hand preference predicted differences in the scores on the 20 hand preference items; left-handers in all three age groups scored significantly more left sided on all 20 items than did their right-handed cohorts. Because of the age differences related to the classification accuracy of individual preference items and because self-classification as right- or left-handed predicted significant differences in responses to the 20 individual preference items, we categorized individuals as right- or left-handed based on their self-classification.
Report of Health History Among Right- and Left-Handers

The combined arguments of the pathological left-handedness and the elimination hypotheses promote the idea that left-handers are at greater risk for major disease occurrence. Since Geschwind and Behan (1982) reported on an association between immune disorders and left-handedness (mediated by the effect of fetal testosterone on the development of the left hemisphere and on immune system functioning), there also has been considerable research interest in the association between handedness patterns and this specific subset of chronic illness types. Our inventory included queries about specific illnesses and health disorders; participants were instructed to answer "yes" if he or she was presently suffering from the condition, "no" if he or she had never suffered from the condition, and "previously" if he or she had suffered from the condition in the past but was currently not suffering from the condition. We then divided the conditions into the categories of immune illness (arthritis, allergies, asthma, diabetes, ulcers or intestinal disorders, skin disorders, and skin disorders) and other illness (emphysema, blood pressure problems, heart disease, circulation problems, major organ disease, cancer, anemia, stroke, and epilepsy). The illness conditions included in the immune category were based on the meta-analysis of the relation between immune disorders and left-handedness conducted by Bryden, McManus, and Bulman-Fleming (1994).

Mean scores were based on the number of "yes" responses to items in the illness categories. Each participant provided a mean score for the immune illness category and another for the other illness category. Group means for all age and hand preference subgroups in both illness categories are shown in Table 1. Included in Table 1 is the percentage of each age and hand preference group reporting one or more occurrences of individual disorders in each illness category. Data from the two illness categories were analyzed in separate 2 (hand preference type) x 3 (age category) between-subject analyses of variance. As expected, both analyses showed a significant main effect of age, \( F(2, 381) = 22.63, MSE = 0.94, p < .01 \), for reports of immune disorders, and \( F(2, 381) = 29.22, MSE = 0.49, p < .01 \), for reports of other illnesses. Individual contrasts indicated that the mean of the young adults, \( t = -5.52, p < .01 \), was significantly different from that of the oldest old group for reports of immune disorders; for reports of other illness the mean of both the young adult, \( t = -6.44, p < .01 \), and the older adult, \( t = -2.61, p < .01 \), differed significantly from that of the oldest old group. There was also a significant Age \( \times \) Hand Preference Type interaction in the analysis of the reports of other illnesses, \( F(2, 381) = 3.38, MSE = 0.49, p < .05 \). The oldest old right-handers reported the highest mean number of other illnesses when compared to the individuals in the other age and preference categories.

The data in Table 1 also show that a higher percentage of individuals in all age and hand preference groups reported one or more immune illnesses when compared to the percentage reporting other types of illness. Once again, as expected, the
TABLE 1
Mean Number of Immune and Other Illnesses Reported by Left- and Right-Handed Respondents and the Percentage of Each Group Reporting One or More Illnesses

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>18–30</th>
<th>55–74</th>
<th>75–94</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
<td>R</td>
<td>L</td>
</tr>
<tr>
<td>Immune illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>0.64</td>
<td>0.84</td>
<td>1.39</td>
</tr>
<tr>
<td>SD</td>
<td>0.78</td>
<td>0.79</td>
<td>1.11</td>
</tr>
<tr>
<td>Other Illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>0.31</td>
<td>0.18</td>
<td>0.57</td>
</tr>
<tr>
<td>SD</td>
<td>0.61</td>
<td>0.38</td>
<td>0.83</td>
</tr>
<tr>
<td>Percentage with one or more immune illnesses</td>
<td>47.7%</td>
<td>61.5%</td>
<td>75.8%</td>
</tr>
<tr>
<td>n</td>
<td>51</td>
<td>59</td>
<td>69</td>
</tr>
<tr>
<td>Percentage with one or more other illnesses</td>
<td>24.3%</td>
<td>17.7%</td>
<td>39.6%</td>
</tr>
<tr>
<td>n</td>
<td>26</td>
<td>17</td>
<td>36</td>
</tr>
</tbody>
</table>

Note. No significant differences among means or percentages were found. L = left-handed; R = right-handed.

The highest percentage of individuals reporting one or more of both categories of illness occurred among the oldest old adults. Chi-square analyses of each age group revealed no significant differences between right- and left-handers in the percentage of individuals reporting illness occurrence versus those reporting no illnesses, $p > .05$.2,3

In addition to the queries about illness, we asked participants three questions concerning their state of wellness during the 12 months prior to this assessment: (1) "How many times have you seen a medical doctor for any reason?"; (2) "How many days were you in bed all or most of the day because of illness or health

We asked three additional questions concerning the occurrence of psychiatric disorders and substance abuse problems. The response rate was very low with a mean number of occurrences below 1.0 for all age groups; no significant effects related to hand preference emerged.

We conducted four additional analyses of variance on the data related to the reported occurrence of immune and other illnesses by classifying hand preference according to writing hand side and, again, by classifying hand preference based on a composite index of 11 items related to skilled preference activities from the 20-item inventory. These were: Eat with a fork (without a knife), brush teeth, draw, throw a ball, cut with a knife, hammer a nail, cut with scissors, hold a sport racket, write, use a comb, and strike a match. The pattern of results did not change regardless of the manner used to specify the hand preference independent variable. All four of the analyses showed a main effect of age but no effect related to the side of hand preference.
conditions?"; and (3) "How many days did you spend in a hospital?" In general, the sample exhibited a high level of wellness as measured by these questions because "0 times" was the most prevalent response to each question among the individuals in all the age and preference categories. For this reason, we dichotomized the data for each of the three questions and collapsed across age categories in order to compare the response patterns of right- versus left-handers. One hundred and eighty-five individuals in the total sample (47.8%) reported seeing a medical doctor "3 or more times" (vs. "0 to 2 times") during the year prior to the study. Among left-handers, the rate of response of "3 or more times" was 50.2% (n = 111) as compared to 44.6% (n = 74) for the same response category among right-handers. Only 29 individuals, or 7.5% of the sample, reported being bedridden with illness for "1 week or more" (vs. "0 to 6 days") during the previous year. Nine percent of left-handers (n = 20) and 5.5% (n = 9) of the right-handers responded in this way. The chi-square analyses comparing the two hand preference types on the dichotomous response categories for these two questions did not indicate significant effects, p > .05. The question concerning hospital stay produced a response from only 6 individuals, or 1.6% of the sample, in the category "1 week or more"; therefore, these data were not analyzed further.

Report of Accidental Injury Among Right- and Left-Handers

The recent literature on the relation between handedness patterns and accident risk predicts that left-handers would be more likely than right-handers to have experienced a major accident, such as a vehicle accident while driving (Coren, 1989, 1992; Coren & Halpern, 1991). In addition, Coren (1992) argued for "the hazardous life of the southpaw" with demonstrations of the everyday minor accidental risk factors associated with various types of tool use by left-handers operating in an implement environment designed for the right-handed majority.

Our inventory included questions centering on the individual's history of both major and minor accidents. Participants were asked how many times in their adult life they had experienced a vehicular accident while driving, or a work-related accident. In addition, all participants were asked to rate the ease of use of the following implements: manual can opener, electric table or hand saw, slicer or electric knife, scissors, knives, computer keyboard, and ruler. These items were chosen from the list of implements discussed by Coren (1992) that are normally right-biased and, therefore, potentially risky or awkward for left-handed use. Individuals rated the ease of use of these items on a 4-point scale ranging from 1 (very easy) to 4 (very difficult). In addition, each participant was asked if she or he had ever injured their hand or hands using any of these implements or tools.

One hundred and seventeen individuals (30.2% of the sample) reported vehicular driving accidents, and 69 participants (17.8% of the sample) indicated some
work-related accident history. Table 2 shows the mean number of vehicular driving and work-related accidents reported by these individuals categorized by hand preference and age. Separate 2 (hand preference type) × 3 (age group) analyses of variance, one for each accident type, revealed no significant main effects or interactions, \( p > .05 \). We dichotomized the data into a report of "0" vehicular driving and work-related accidents versus "1 or more" such accidents. The data were collapsed across age categories and then analyzed with a chi-square analysis for each accident type. Overall, 33.5% (\( n = 74 \)) of all left-handers reported one or more vehicular driving accidents as compared to 25.9% (\( n = 43 \)) of right-handers; 20.4% (\( n = 45 \)) of all left-handers and 14.5% (\( n = 24 \)) of right-handers indicated the experience of "1 or more" work-related accidents. Although the rate of accident occurrence in both instances was higher for left-handers, chi-square analyses did not produce significant effects, \( p > .05 \).

A number of investigators have used the methodology of epidemiologists to look at the relation between hand preference types and accident risk (Coren, 1989; Peters & Perry, 1991; Porac, 1993). In this type of analysis, an odds ratio (OR) is computed. When the value of the ratio is greater than 1, then the accident risk is increased when an individual is exposed to the risk factor under study, namely, left-hand preference. If the ratio is lower than 1, the accident risk is reduced in the presence of the risk factor. ORs equal to 1 indicate that the risk factor (left-hand preference) and the variable under study (accident occurrence) are not related (in other words, an OR of 1 is the \( H_0 \)). In addition, if the 95% confidence interval (CI) surrounding the OR includes the \( H_0 \) value of 1, the OR is not regarded as significant (Kahn & Sempos, 1989). We collapsed across age groups and computed ORs for both the vehicular driving and work-related accident data; these were OR = 1.44 (95% CI = 0.92, 2.25) for the driving accident data and OR = 1.51 (95% CI = 0.88, 2.60) for the work-related accident rates. In both instances, the ORs were

### Table 2

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>18–30</th>
<th>55–74</th>
<th>75–94</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
<td>R</td>
<td>L</td>
</tr>
<tr>
<td>Vehicle accidents (driver)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>1.20</td>
<td>1.67</td>
<td>1.69</td>
</tr>
<tr>
<td>( SD )</td>
<td>0.41</td>
<td>0.82</td>
<td>1.15</td>
</tr>
<tr>
<td>Work-related accidents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>1.40</td>
<td>2.75</td>
<td>2.43</td>
</tr>
<tr>
<td>( SD )</td>
<td>0.82</td>
<td>2.06</td>
<td>4.20</td>
</tr>
</tbody>
</table>

*Note.* No significant differences among means were found. \( L = \) left-handed; \( R = \) right-handed.
greater than 1, indicating an increased risk of accidents among left-handers; however, the CIs in both instances included the $H_0$ value and, therefore, the risk increase was considered nonsignificant.

We assessed the variables of everyday inconvenience and minor accident risk in implement use by dichotomizing the list into cutting tools (can opener, table or hand saw, slicer or electric knife, scissors and knives) and other tools (computer keyboard and ruler). We then subjected the mean ease-of-use scores calculated for each of these two categories of implements to a 2 (hand preference type) × 3 (age group) between-subject multivariate analysis of variance. With the use of Pillais criterion, the combined cutting tools versus other tools dependent variables were affected by hand preference type, $F(2, 380) = 27.63, p < .01$, age group, $F(4, 762) = 12.34, p < .01$, and the interaction between them, $F(4, 762) = 3.01, p < .05$. To investigate the impact of the hand preference and age group main effect on the individual dependent variables, Roy–Bargman stepdown analyses were performed (Tabachnick & Fidell, 1996). A significant unique contribution of hand preference type was only apparent for the mean scores for cutting implements, stepdown $F(1, 381) = 55.26, MSE = 0.26, p < .01$; in contrast, age group of the participant made a significant contribution to both dependent variables, stepdown $F(2, 381) = 16.15, MSE = 0.26, p < .01$ for cutting implements, and stepdown $F(2, 380) = 9.31, MSE = 0.20, p < .01$ for other tools. The individual interaction effect was only significant for the cutting implement mean scores, stepdown $F(2, 381) = 5.19, MSE = 0.26, p < .01$. These data are shown in Figure 1.

Figure 1 shows the mean ease-of-use scores divided into an “easy” range, scores below 2.5, and a “difficult” range, scores above 2.5. The ratings of the ease of use of cutting implements were higher for left-handers when compared to right-handers at all age levels, with the oldest old left-handers showing the highest mean scores. The mean scores related to the ease of use of noncutting implements were similarly low for both right- and left-handers, with young adults showing slightly higher mean scores than the two older adult groups. However, the ease-of-use ratings for both hand preference types and all age levels were between 1 and 2, indicating that all participants rated both cutting and other implements as “very easy” or “easy” to use.

We conducted chi-square analyses for each age group on the dichotomized responses to the question, “Have you ever injured your hand using any of these implements?” Forty-nine of the 18- to 30-year-old left-handers (46.7%) and 55 of the 18- to 30-year-old right-handers (57.9%) responded affirmatively. Among the 55- to 74-year-old group, 12.4% ($n = 11$) of left-handers and 25.5% ($n = 13$) of right-handers responded affirmatively.

We conducted two additional multivariate analyses of variance on the ease-of-use data by classifying hand preference according to writing hand side and, again, according to a composite index of 11 hand preference skill items. Both the writing hand and the hand skill analyses mimicked the results of the original analysis by showing a main effect of hand preference side for cutting tools only, and an age group main effect for both cutting and other types of implements.
right-handers answered "yes." Two of the oldest old adult left-handers (8.7%) reported an implement-related injury as compared to 27.8% (n = 5) of the right-handers in this group. The chi-square values computed for the individual age groups were not significant, $p > .05$.

DISCUSSION

These results are interesting from several viewpoints. First, our data collection efforts were able to identify over 100 left-handers in the population over the age of 55 years, including 23 in the 75 to 94 year age range. Thus, the zero incidence rate
of left-handed types in the age range above 76 years (Coren, 1995a) does not reflect the true prevalence of manifest left-handedness in this age group. Second, we did not find evidence for a relation between left-handedness and increased disease occurrence (whether immune illness or other illness) or decreased general wellness. The only effect that emerged relative to the disease variables was an age-related one in which older adults reported the occurrence of more illnesses. One might be tempted to argue that the oldest old adults in the sample represent a group with exceptional survival fitness, which results in an exceptionally high level of health and wellness among them. However, relations of hand preference to the health variables were not apparent even among the young adults, who served as the control group for generational and survival fitness variables. Thus, our findings, with a relatively large sample of left-handers, do not support the notion of a pathologically determined form of left-hand preference that is associated with greater risk of disease occurrence. Third, the accident occurrence and accidental injury comparisons also did not produce any differences between right- and left-handers. Contrary to predictions from the elimination hypothesis, right-handers rather than left-handers more frequently reported suffering hand injuries related to the use of common household implements. Left-handers gave significantly higher ease-of-use ratings to the manipulation of cutting implements, such as scissors, when compared to right-handers, but neither hand preference group used ratings that were in the difficult or very difficult range. Evidence supporting the existence of powerful accidental injury hazards in place for left-handers living in a right-handed world was not apparent in our sample. Although the odds ratios for the risk of major accidental injury showed a greater risk associated with left-hand preference, statistical analysis revealed that the risk increase was not significant.

Our data have several implications for genetic theories of hand preference formation. First, the left-handers in this sample did not manifest an alinormal syndrome; in other words, they did not show an association between left-handedness and disease occurrence that is presumably mediated by neuropathology of some type. If their left-handedness was the result of a pathologically determined switch from genetic right-handedness, then the associated neurological differences did not lead to increased disease susceptibility. Second, there was little evidence for a “clumsiness” factor (Coren, 1992) among left-handers when examined against a comparable group of right-handers.

Our data support the role of life experience factors in the formation of hand preference patterns, as suggested by Laland et al. (1995) in their gene-culture model of handedness. For example, 99 of the 221 self-classified left-handers (44.8%) in our sample reported an attempt to shift their handedness toward the right side. Because these individuals still classified themselves as left-handed, presumably, these were the “stubborn” left-handers discussed by Harris (1990), who remained left-handed despite attempts to change the preference pattern. Fourteen of the 166
self-identified right-handers (8.4%) reported rightward shifts; this figure could be used as a rough estimate of the success rate of hand preference switch attempts.

We also observed generational differences in our sample in regard to reports of hand preference shift attempts. Twenty-six of 107 young adult left-handers (24.3%) and 6 of 96 right-handers (6.3%) reported rightward switch attempts. If the latter incidence rate of 6.3% represents successful shifts, it is an estimate of the rate of induced right-handedness among individuals raised in the 1960s and 1970s. Among the older adult groups, the rate of rightward shift attempts reported by left-handers was 59.3% (n = 54) in the 55- to 74-year-old category and 82.6% (n = 19) in the oldest old adult group. The reported incidence rate of successful shifts, that is, self-identified right-handers reporting a rightward switch attempt, was 11.8% (n = 6) among individuals in the 55- to 74-year-old group and 10.5% (n = 2) among the 75- to 94-year-old participants. Our data support the generational change in the 20th century, in which cultural attitudes in North America and Great Britain against left-hand use drifted toward greater acceptance during the early decades of the century (Harris, 1990). Oldest old adult left-handers, raised during the decades of the 1910s and 1920s, showed an incidence rate of switch attempts that was approximately 3.5 times higher than that found among the young adult left-handers.

Laland et al. (1995) proposed that natural selection favoring right-handedness has altered the probability of becoming right-handed from 50% to an estimated 78%. If one takes the estimate of 78% as the incidence rate of right-handedness in a population determined by genotype and add to it the rate of successful right shifts as estimated from our sample (6.3% among young adults and 10.5% among oldest old adults), the rate of right-handedness among young adults would rise to 84.3%; among oldest old adults, it would rise to 88.5%. Porac (1996a) reported an 89.7% rate of right-handedness among individuals under 30 years old and 96.9% among individuals over 60 years old in survey data collected in British Columbia, Canada. The estimates from the Laland et al. (1995) model, combined with the preference switch estimates from our sample, underestimate the observed prevalence rates of right-handedness, especially for older adults. However, this type of genetic-environment interaction analysis is useful in attempting to account for the manifest complexities of human handedness types. Porac (1995a, 1995b) argued that life experience factors must be taken into account by genetic theories because these influences are meaningful forces in the formation of hand preference side and strength. It is also possible that genetic determination of human hand preference is

5Of the individuals in the sample who reported preference shifts toward the right side, 90.3% (n = 105) indicated that the attempt occurred during or before the primary school years. These data support previous reports that right shift attempts typically are early childhood experiences (Porac, Coren, & Searleman, 1986; Porac, Rees, & Buller, 1990).
more complex than that conceptualized in several of the most prominent contemporary models (Annett, 1985; Coren, 1994, 1995b; McManus, 1985). Recent work involving the study of hand preference in human twin pairs and paw preference in mice supports the idea that genetic factors that influence the formation of lateral preference behaviors are intricate and may be linked to phenotypical variation in ways that are not yet understood (Biddle & Eales, 1996; Derom, Thiery, Vlietinck, Loos, & Derom, 1996; Lipp et al., 1996). In summary, regardless of the complexity of the genetic involvement, genetic models that incorporate the possibility of nonpathological influences on hand preference genotype are supported by this data. However, we found little evidence for atypical symptomatology among any of the left-handers in our sample.

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