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## **Handedness and Musical Ability: A Study of Professional Orchestral Players, Composers, and Choir Members**

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The handedness of three groups of accomplished musicians (623 instrumentalists, 331 composers, and 584 choir members) was assessed using a standard questionnaire (Oldfield, 1971). While the three groups of musicians did not differ from one another, there was evidence of a modest, but significant, increase in the proportion of left-handers and mixed-handers among the musicians when compared with a normal population. It was found, for example, that 12.2% of the male and 11.8% of the female musicians were left-handed as defined by the Laterality Quotient (Oldfield, 1971). These figures compared with 8.5% male and 7.3% female left-handers in their respective age-matched control groups. Further evidence of an increased proportion of left-handed musicians was found for the single item, writing hand. This latter finding suggests that the differences in handedness were not simply a consequence of musical training.

### **Introduction**

Interest in the incidence of left- and right-handedness amongst musicians stems from a desire to understand those factors that might be associated with musical ability. There is a popular notion that people engaged in artistic pursuits are more likely to be left-handed and examples of famous left-handed musicians can readily be called to mind (e.g. C. P. E. Bach, Cole Porter, Paul McCartney, and Jimi Hendrix). Furthermore, a number of influential theories concerning the nature of handedness make predictions about handedness and musicality. For example, in discussing the "Right-Shift" theory of handedness Annett (1985) suggests that the highly skilful playing of musical instruments might be more difficult among strong right-handers than among weak right-handers (Annett, 1985, p. 405). Another prediction comes from the theory of Geschwind and Galaburda (1985) which relates the enlargement of the right cerebral hemisphere with not only left-handedness, but also with higher than average levels of abilities associated with the right hemisphere. These may include some aspects of musical ability (Gates and Bradshaw, 1977; Gordon, 1983).

The few quantitative studies that have examined the association between musical ability and handedness have, however, found equivocal results. Thus of four previous studies, two found a normal incidence of left-handedness among musicians (Oldfield, 1969; Gotestam, 1990), one reported a slight increase in the incidence of left-handedness (Fry, 1990), while a fourth found no change in the numbers of left-handers but an increase in the proportion of mixed-handers (Byrne, 1974). In all four studies the research concentrated on students at schools of music.

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In view of these intriguing, but inconsistent, results we re-examined this issue using professional and semi-professional musicians rather than students. Evidence that this might be informative came from a much earlier report of increased levels of "sinistrality" among professional musicians (Quinan, 1922). The use of professional performers also allowed us to examine much larger groups of musicians than had been attempted in previous studies. The present study examined handedness among three groups of accomplished musicians; professional orchestral players, professional composers, and members of professional or semi-professional choirs. These groups were chosen because they reflect different aspects of musical ability.

Handedness was measured in two different ways. First, as a composite measure (the Laterality Quotient) drawn from ten items on the Edinburgh Handedness Inventory (Oldfield, 1971). Second, from the single action, writing hand. This action was chosen because it is most unlikely to be influenced by musical training. In addition, questionnaire answers for this item correlate extremely highly with observed action (Raczkowski, Kalat and Nebes, 1974; Annett, 1985). From the composite measure of handedness the subjects were categorised as either strong left-handers, moderate left-handers, moderate right-handers, or strong right-handers. These divisions were chosen in response to evidence that subjects who are consistently right-handed tend to perform more poorly on tests of pitch memory (Deutsch, 1978, 1980). These divisions also made it possible to assess the prediction, derived from the "Right-Shift" theory, of a relative lack of extreme dextrals among skilled instrumentalists (Annett, 1985, p. 405).

## Method

### *Professional Instrumentalists*

The manager or chief executive of 19 orchestras was sent a standard letter outlining our interest in handedness and requesting the co-operation of the orchestra in our research. Following a positive reply the orchestras were sent a standard letter and copies of the 10-item Edinburgh Handedness Inventory (Oldfield, 1971). Care was taken not to bias any of the letters or questions so that it might be thought that we were expecting an unusually high level of left- or right-handers. The questionnaires were distributed and collected by the various orchestras themselves, and the total number handed out within any orchestra noted.

Seventeen professional orchestras agreed to participate in the study. These were: The Scottish National Orchestra, The BBC Symphony Orchestra, The Royal Opera, The BBC Philharmonia, The English Northern Philharmonia, The Halle Orchestra, The Bournemouth Symphony Orchestra, The BBC Scottish Symphony Orchestra, The BBC Welsh Symphony Orchestra, The BBC Radio Orchestra, The Royal Liverpool Philharmonic Orchestra, The Philharmonia, The Northern Sinfonia, The National Symphony Orchestra, Welsh National Opera, The Royal Philharmonic Orchestra, and The London Symphony Orchestra.

### *Professional Composers*

A standard letter outlining our interest in handedness and musical ability was sent to all of the male composers listed as belonging to the Composers

Guild of Great Britain or to the Association of Professional Composers in the 1991 edition of the *British Music Yearbook* (Carter, 1990). This letter also contained a copy of the 10-item Edinburgh Handedness Inventory (Oldfield, 1971). If a response was not received within two months a second letter was sent reminding recipients of the original request and containing another copy of the questionnaire. Female composers were not included in this study in view of the small number listed in the *British Music Yearbook* (Carter, 1990).

### *Choral Groups*

Ten leading choirs (English Baroque Choir, London Philharmonic Choir, Britten Singers, Royal Choral Society, Glyndebourne Chorus, Bach Choir, Leeds Festival Chorus, Philharmonia Chorus, BBC Singers, Opera North Chorus) all of whom were listed in the *British Music Yearbook* (Carter, 1990) agreed to participate in the study. The procedure was the same as that for the orchestra members.

### *Control Groups*

Normative data for the composite measure of handedness (Laterality Quotient, LQ) were drawn from a survey of 6,097 people aged 15–70 years living in a British town (Ellis, Ellis and Marshall, 1988). This sample consisted of the 82% of people in a general medical practice who had returned completed copies of the 10-item Edinburgh Handedness Inventory (Oldfield, 1971).

Not only had the handedness of this group been assessed in an identical manner to that in the present study, it was also possible to adjust the control group to help match for effects of gender and age. The latter effect is particularly important as it has repeatedly been shown that in cross-sectional surveys the incidence of left-handedness decreases markedly with age (Fleminger, Dalton and Standage, 1977; Porac, Coren and Duncan, 1980; Davis and Annett, 1994). For this reason each subject in the three musical groups was matched with a single subject of the same sex whose age was in the same decade. These control subjects were drawn randomly without replacement from the control data, *i.e.* repeats among the control subjects were excluded. This refinement in the selection of the control population was made possible by the provision of a more detailed breakdown of the LQ scores for the male and female subjects grouped by decade of age (Ellis, personal communication).

Data for the individual item “writing hand” were not available from the study of Ellis *et al.* (1988). Comparisons were therefore made with a mail survey of adult people selected at random from the electoral role of four British cities (Davis and Annett, 1994). In this survey the subjects were asked to respond to the item “With which hand do you normally write?”. A total of 33,401 usable replies were received, a response rate of about 80% (Davis and Annett, 1994). The published results (see Table 1; Davis and Annett, 1994) made it possible to construct a control set of subjects in which age (in decade) and sex were matched. This was achieved by taking the number of male and female musicians in each age decade and calculating the number that would write with the left or right hand according to the percentages found in this normal population. The totals in each decade were then combined to produce control groups of equal size to those of the male and female musicians.

TABLE 1

The frequency of Laterality Quotient scores (Oldfield, 1971) among the three groups of musicians and the Control subjects (percentages in parentheses). The control data are taken from the survey by Ellis *et al.* (1988). To allow for the factors sex and age, each Control subject was matched with a musician of the same sex and in the same age decade.

	<i>Strong LH</i>	<i>Moderate LH</i>	<i>Moderate RH</i>	<i>Strong RH</i>
Laterality Quotient	-100 to -60	-59 to 0	+1 to +59	+60 to +100
Instrumentalists (male)	27 (6.3)	25 (5.8)	52 (12.1)	327 (75.8)
Instrumentalists (female)	15 (7.8)	9 (4.7)	16 (8.3)	152 (79.2)
Composers (male)	19 (5.7)	17 (5.1)	35 (10.6)	260 (78.5)
Choir Members (male)	25 (10.2)	9 (3.6)	23 (9.4)	187 (76.6)
Choir Members (female)	24 (7.1)	15 (4.4)	45 (13.2)	256 (75.3)
Controls (male)	58 (5.8)	28 (2.8)	83 (8.3)	837 (83.2)
Controls (female)	32 (6.0)	11 (2.1)	47 (8.8)	442 (83.1)

## Results

A total of 1,538 questionnaires were returned by the three groups of musicians. Of these, 623 completed questionnaires were returned by the 17 orchestras (51% return rate). The median age of the 431 male orchestral players was 42 (range 21 to 74) while that of the 192 female players was 32 (range 23 to 60). A total of 331 male composers returned completed questionnaires (92.5% return rate). The ages of the composers ranged from 29 to 93, the median age being 53. Returns were also received from 584 (244 male, 340 female) choir members (61% return rate). The median age of the male respondents was 44 (range 19 to 73) while that of the females was 38 (range 17 to 71).

The Laterality Quotient (LQ), which is compiled from all ten responses on the Edinburgh Handedness Inventory (Oldfield, 1971), was calculated for each return. Taking all of the returns it was found that 12.2% of the male musicians ( $n = 1,006$ ) and 11.8% of the female musicians ( $n = 532$ ) were left-handed (*i.e.* had a Laterality Quotient of zero or less). The corresponding percentages for the control groups were 8.5% (male) and 7.3% (female). The responses were then further divided into "strong left-handers" (LQ -100 to -60), "moderate left-handers" (LQ -59 to 0), "moderate right-handers" (LQ +1 to +59), or "strong right-handers" (LQ +60 to +100). For the purpose of statistical analyses these four handedness classifications were considered in terms of two factors, handedness and degree of handedness, each of which have two different levels (left *v.* right and moderate *v.* strong). The analysis then sought to determine whether subjects' sex, being a musician, or the type of musician, played a significant role in predicting their handedness, the degree of their handedness, or an interaction between these two factors.

This analysis was achieved by fitting a series of hierarchical log-linear models to the data (Nelder, 1974). In this way the effects of sex, being a musician, and type of musician, were successively taken into account in combination with handedness and degree of handedness (Table 2). The contribution of

each of these factors was determined by the change in the goodness of fit of the hierarchical log-linear model produced when that factor was added to the model. The initial model simply fitted the data to a classification in terms of the subjects' handedness, degree of handedness, and to the seven subject groups (ignoring classification of those seven groups in terms of sex or musical characteristics). The effects of subjects sex were then analysed by adding terms for its interaction with handedness, degree of handedness, and their interaction to the model. Similarly the effects of being a musician were investigated by adding terms for that factor successively to the model. Finally, terms involving interactions with type of musician were added to the model.

TABLE 2

Table of results for hierarchical log-linear model comparing the three groups of musicians with the matched control set taken from Ellis *et al.* (1988). The various effects are: "Hand", direction of handedness (LQ>0 *v.* LQ<0); "Deg", degree of handedness (absolute LQ >60 *v.* absolute LQ <60); "Musician", whether control subject or musician; "Musician type", which of the three different groups of musicians; and Sex.

	<i>df</i>	<i>Chi-square</i>	<i>Change df</i>	<i>Change Chi-square</i>
(Hand × Deg) + Group	18	33.42	—	—
Hand × Sex	17	33.15	1	0.27 ns
Deg × Sex	16	33.14	1	0.01 ns
Hand × Deg × Sex	15	32.43	1	0.71 ns
Hand × Musician	14	23.10	1	9.33 <i>p</i> <.005
Deg × Musician	13	10.63	1	12.44 <i>p</i> <.001
Hand × Deg × Musician	12	10.34	1	0.29 ns
Hand × Musician type	10	9.34	2	1.00 ns
Deg × Musician type	8	9.21	2	0.13 ns
Hand × Deg × Musician type	6	6.58	2	2.63 ns

The results of these analyses are shown in Table 2. It was found that there were no systematic effects of sex, handedness, the degree of handedness, or their interaction. There were, however, significant interactions between handedness and being a musician (change in  $X^2 = 9.321$ ,  $p < 0.005$ ), and between degree of handedness and being a musician (change in  $X^2 = 12.44$ ,  $p < 0.005$ ). These effects were due to a greater proportion of left-handed musicians and to a relative loss of "strongly" handed musicians (*i.e.* those with an absolute LQ greater than 59). No systematic effects of type of musician, or its interactions with handedness and degree of handedness, were found.

The writing hand of all of the musicians was determined from that item in the Edinburgh Handedness Inventory (Oldfield, 1971). The very small number of musicians who reported using either hand for writing ( $n = 14$ ) were divided between the left and right groups according to their Laterality Quotient (LQ of 0 or less being designated left-handed). The proportion of male musicians who preferred using their left hand for writing was 12.5%, while that of the female musicians was 12.6%. The respective percentages for the control group derived from the data of Davis and Annett (1994) were 8.0% (males) and 7.9% (females). Comparisons between these populations (Table 3) showed

that there were more left-handed writers among the total population of both male ( $X^2 = 11.44$ ,  $p < 0.001$ ) and female ( $X^2 = 6.40$ ,  $p = 0.012$ ) musicians. Further comparisons using the separate groups of musicians (sexes combined) with their own age-matched controls (Davis and Annett, 1994) indicated that both the orchestral players ( $X^2 = 6.90$ ,  $p = 0.009$ ) and the choir members ( $X^2 = 8.73$ ,  $p = 0.003$ ) contained a relatively high proportion of left-handers. While there were relatively more left-handed composers this difference was not significant ( $X^2 = 2.40$ ).

TABLE 3

The frequency of left and right responses to the item "Writing" on the Edinburgh Handedness Inventory (Oldfield, 1971). The "matched control" data are derived from Davis and Annett (1994) which provides normative data for writing hand with regard to both age and sex. This made it possible to construct a series of hypothetical control groups, each matched against a particular experimental group and having the same number of subjects.

	Writing Hand	
	Right	Left
Orchestras — males	374	57
(matched controls)	393.1	37.9
Orchestras — females	166	26
(matched controls)	176.3	15.7
Choirs — males	208	36
(matched controls)	223.7	20.3
Choirs — females	299	41
(matched controls)	313.9	26.1
Composers — male	299	33
(matched controls)	310.0	22.0

Finally, we compared the handedness of players of different instruments (sexes combined) using the laterality quotient. Divisions were made between stringed, woodwind, and brass instruments on the basis that the strings require different skilled movements from two hands, woodwind makes similar demands on the two hands but also requires considerable mouth and breath control, while brass playing primarily depends on mouth and breath control combined with additional demands on the right hand (or the left hand for the French horn). It was found that the proportion of left-handers (by LQ) was very similar between the brass (15:78) and woodwind (14:78) players. Although there were relatively fewer left-handers among the string players (37:361) this difference was not significant (*v.* brass,  $X^2 = 3.72$ ; *v.* woodwind,  $X^2 = 2.81$ ), unless the players of those instruments requiring blowing (brass and woodwind) were combined ( $X^2 = 5.12$ ,  $p < 0.05$ ). There was also evidence of more "mixed" handed players (*i.e.* LQ between  $-60$  and  $+60$ ) among the combined brass and woodwind players (13 left: 38 mixed: 134 right) than among the string players (27 left: 48 mixed: 323 right:  $X^2 = 7.39$ ,  $df 2$ ,  $p < 0.05$ ). Out of interest it was noted that there were relatively more left-handers (by LQ) among the violin and viola players than among the cello and double-bass players ( $X^2 = 5.78$ ,  $p < 0.05$ ).

### Discussion

The findings of the survey suggest that there is a small increase in the incidence of left-handedness among accomplished musicians. Further examination of the LQ scores indicated that the handedness changes among the musicians reflected an increase in both mixed and left-handed subjects. There were, however, no differences between the three groups of musicians. Evidence for an increase in left-handedness came not only from the composite measure (LQ), but also for the single item, writing hand. This is of interest because although musical training could possibly influence some of the items in the Edinburgh Handedness Inventory (Oldfield, 1971) it is extremely unlikely that it could alter the choice of writing hand.

An important issue concerns the choice of control group. The present study used data from a general population in whom handedness had been assessed in an almost identical manner (Ellis *et al.*, 1988). While it was not possible to match for factors such as educational level, it was possible to match for other factors that are known to influence handedness, *i.e.* age and gender. Care was therefore taken to match these factors as precisely as possible by constructing a matched set of controls from the normal population reported by Ellis *et al.* (1988). Similar factors determined the choice of the comparison data for the single item, writing hand, so that once again it was possible to match closely for age and gender.

A further issue arises from the use of mail surveys as a means of assessing handedness. In particular, there is the possibility of a systematic bias among those musicians who did not respond. Studies which have examined whether left-handers are more (or less) likely to reply to handedness questionnaires have found conflicting results (Wood and Aggleton, 1991; Cornell and McManus, 1992). We therefore examined the returns from the four orchestras and the four choirs with the best return rates (overall 90.2%). These showed that 11.6% of the males ( $n = 225$ ) and 9.3% of the females ( $n = 161$ ) were left-handed according to their LQ. These proportions did not differ from those found in all of the remaining instrumentalists and choir members (males  $X^2 = 0.01$ , females  $X^2 = 0.74$ ). Among the composers the return rate was extremely high, so minimising any possible bias effect. Finally, it should be noted that the control data used for both Laterality Quotient (Ellis *et al.*, 1988) and hand writing (Davis and Annett, 1994) comparisons also came from mail surveys.

The finding of an increase in the frequency of left- and mixed-handedness among musicians may seem at odds with some of the previous null results (Oldfield, 1969; Gotestam, 1990). But, given the relatively small increase in the numbers of left-handers this difference may well reflect the use of much larger samples of musicians and control subjects. Other factors include the focus on successful, professional musicians rather than students of music, and the use of an age and sex matched control group. It may therefore be relevant that the studies of Byrne (1974) and Oldfield (1969) included older members of staff among the musicians, although there were no comparable older subjects among the control groups. This may be of importance as sinistrality decreases in older age groups (Fleminger *et al.*, 1977; Porac *et al.*, 1980).

Part of the rationale for the present study arose from speculations about those abilities associated with particular patterns of handedness. One obvious

possibility is that mixed-handedness should be favoured among instrumentalists as there is a demand for highly accurate, rapid motor co-ordination, often involving both hands. In support of this there is evidence that left-handed people have better motor control of their non-preferred hand than do right-handers (Annett and Kilshaw, 1983; Peters and Durdging, 1978; but see Flowers, 1975). This view also appears consistent with recent evidence that left and/or mixed handers are more frequent among those musicians who play instruments requiring greater bimanual co-ordination (Christman, 1993). As the players of such instruments make up the large majority of all players in the orchestra one might therefore expect more left- or mixed-handers among orchestral players. At first sight this view appears to be supported by the general pattern of the present results, *i.e.* an increase in the proportions of mixed- and left-handers. However, the lack of a difference between the three groups of musicians suggest that if there is such an effect it is not restricted to the highest levels of instrumental performance. Furthermore, predictions based on the particular playing demands of different instruments were not supported. It has, for example, recently been suggested that mixed-handers should be especially prevalent among woodwind players as the two hands are engaged in activity that is both spatially and temporally similar (Christman, 1993). This result was not found as very similar proportions of left-handers were found among brass and woodwind players in spite of the very different demands these instruments make on bimanual co-ordination. Thus, in spite of some evidence of differences between the various types of musical instruments, these effects did not readily match the motor demands of those instruments.

This conclusion leaves the possibility that left-handedness may be associated with other beneficial factors related to music. One source of evidence comes from reports of improved pitch memory among left- and mixed-handers (Deutsch, 1978, 1980) and for improved memory for rhythmic sequences by left-handers (Craig, 1980). The link with the findings of Deutsch (1978, 1980) is supported by the fact that the clearest difference between the overall group of Musicians and the Control group was the lack of consistent right-handers (LQ +60 or more). It was this same group that were poorest on the pitch memory tasks (Deutsch, 1978). There is also evidence that musicians, including composers, show reduced functional cerebral asymmetries for verbal processing (Hassler, 1990), and this might prove to be associated with changes in handedness.

Finally, it should be remembered that the apparent increase in the incidence of left- and mixed-handedness among expert musicians may reflect a difference in the handedness of those starting formal musical training, rather than a difference in their final achievement levels. It may, for example, be the case that left- and mixed-handers find the fingering of many instruments easier in the initial stages and hence are more likely to persevere. In order to test this it would be necessary to compare pupils from the earliest stages of musical training.

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