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Pitch Memory: An Advantage for the Left-handed

Abstract. *In an auditory or musical memory task, subjects made pitch recognition judgments when the tones to be compared were separated by a sequence of interpolated tones. The left-handed subjects performed significantly better than the right-handed and also had a significantly higher variance. Further analysis showed that the superior performance was attributable largely to the left-handed subjects with mixed hand preference*

People who are left-handed differ as a group from those who are right-handed and display more heterogeneity, in terms of both direction and degree of cerebral dominance. (i) In the overwhelming majority of the right-handed population, speech is represented in the left cerebral hemisphere; however, in about two-thirds of the left-handed population, speech is represented in the left hemisphere and in about one-third, in the right. (ii) Although the right-handed tend to show a clear-cut dominance of the left hemisphere for speech, a considerable proportion of the left-handed have some speech representation in both cerebral hemispheres (*1*).

Interest has developed in the possibility that such neurological differences might be reflected in differences in various abilities. Thus, some investigators have argued for a relationship between left-handedness or mixed hand preferences and reading disability (*2*). Others have presented evidence that left-handed persons or those with mixed hand preference perform more poorly than right-handed persons on visuospatial tasks (*3*). In contrast, I now report what is, to my knowledge, the first evidence for an association between left-handedness and superior auditory or musical processing ability. The research was prompted by the observation that among subjects selected for high performance on a pitch memory task, an unexpectedly high proportion were left-handed. I therefore planned an experiment to determine whether the two populations differ statistically in terms of their ability to make pitch memory judgments.

A test tone was presented and followed by a sequence of six interpolated tones and then by a second test tone. The test tones were either identical in pitch or differed by a semitone. The subjects indicated on paper whether the test tones were the same or different. All tones were 200 msec in duration and separated by 300-msec pauses, except that a 2-second pause intervened between the last interpolated tone and the second test tone. The tones were sine waves with frequencies taken from an equal-tempered chromatic scale (International Pitch; A = 435 hertz) ranging over an octave from middle C (259 hertz) to the B above (488 hertz). The interpolated tones were chosen at random from this range, except that no interpolated sequence contained repeated tones or tones that were identical in pitch to either of the test tones. Twenty-four sequences were presented in two groups of 12, with 10-second pauses between sequences within a group and 2-minute pauses between the groups. Before the experimental session began, the procedure was explained to the subjects and they were given four practice sequences (*4*).

The subjects were 76 right-handed and 53 left-handed university undergraduates (*5*). The average error rates for these two groups are shown in Table 1. The variance of the left-handed group was significantly higher than that of the right-handed group [$P < .05$ (*6*)]. Further, the left-handed subjects made significantly fewer errors than the right-handed (median test, $\chi^2 = 8.03$, d.f. = 1, $P < .01$) (*7*). Given the larger variance in the left-handed group, I hypothesized that those who were strongly left-handed might differ from those with a mixed preference, since individuals in the latter group would be expected to have more bilateral representation of function (*8*). Each population was therefore subdivided on the basis of strength of manual preference (Table 1) (*9*). There was an overall significant difference among these four subgroups (median test, $\chi^2 = 12.33$, d.f. = 3, $P < .01$). Further, the performance of the left-handers with a mixed preference (moderately left-handed) was significantly more accurate than that of any of the other three groups (Table 1). The other groups did not differ significantly from each other.

Table 1. Performance levels of all four handedness populations on the pitch memory task. Each subgroup was compared with the moderately left-handed subgroup by means of a median test.

Group	*N*	Average Error (%)	χ^2
Right-handed			
Strongly	52	36.9	10.02*
Moderately	24	41.0	9.65*
Total	76	38.1	
Left-handed			
Moderately	23	29.0	
Strong	30	35.3	4.45†
Total	53	32.5	

*$P<.01$. †$P<.05$.

These findings suggest an explanation in terms of a duplication of storage of pitch information by the moderately left-handed. If the efficiency of storage and retrieval at one locus is identical for all populations, then the retrieval of this information from two separate loci should significantly increase the overall probability of correct judgment. We can further hypothesize that such duplication of representation occurs in parallel with the duplication of representation of speech functions in the two hemispheres. We cannot, of course, specify whether the pitch information is retained in the dominant or the nondominant hemisphere in the case of people for whom a more completely unilateral storage is hypothesized (*10)*.

It remains to be determined to what extent the superiority of the moderately left-handed on this pitch memory task generalizes to other auditory or musical situations. However, other left-handed subjects selected for previous experiments on the basis of superior performance on such a task performed unusually well on a variety of tests of musical memory, including the transposition of melodic sequences (*11)*.

The finding that the moderately left-handed differ significantly in performance from the moderately right-handed also demonstrates that the "ambidextrous" should not be considered a single population, as is often assumed. Had the two groups been combined in this study, no significant differences would have been seen (*12)*.

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References and Notes

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4. The tones were produced at equal amplitude by an oscillator (Wavetek) controlled by a PDP-8 computer, and were recorded on tape. They were played to subjects through speakers on a tape recorder (Revox).
5. Handedness was assessed by the short form of the Edinburgh Handedness Inventory [R. C. Oldfield, *Neuropsychologia* **9,** 97 (1971)]. The right-handed were defined as those with positive laterality quotients and the left-handed as those with negative laterality quotients. In both populations, the ratio of male to female subjects was 1 : 1.3. The right-handed subjects had had an average of 3.64 years of musical training (including self training and school choir) and the left-handed subjects an average of 3.77 years.
6. B. J. Winer, *Statistical Principles in Experimental Design* (McGraw-Hill, New York, 1962).
7. No significant differences based on sex were obtained.
8. S. M. Gillies, D. A. MacSweeny, O. L. Zangwill, *Q. J. Exp. Psychol.* **12,** 113 (1960); H. Hécaen and J. Sauget, *Cortex* **7,** 19 (1971); S. J. Dimond and J. G. Beaumont, Eds., *Hemisphere Function and the Human Brain* (Wiley, New York, 1974).
9. The strongly right-handed were defined as those with laterality quotients between +60 and +100; the moderately right-handed, those with quotients between +1 and +59; the strongly left-handed, those with quotients between –60 and –100; and the moderately left-handed, those with quotients between –1 and –59.
10. M. Critchley and R. A. Henson, Eds., *Music and the Brain* (Heinemann, London, 1977).
11. D. Deutsch, unpublished observations.
12. The present criterion for dividing populations into right-handed and left-handed groups correlates highly with hand used in writing. The subject population in this experiment would have had little pressure on them to write with the right hand, in contrast to subjects of earlier studies or those of older patient populations. The importance of the hand used in writing as a criterion for dividing populations accords well with the conclusions of M. Annett [*Br. J. Psychol.* **61**. 303 (1970)]. In a study by B. Byrne [*Br. J. Psychol.* **65**, 279 (1974)], a variant of the Seashore tonal memory test was used to compare the performance of the strongly right-handed with those of mixed hand preference (taken as one group), and no effect of handedness was found. However, I would have found no effect either, had the handedness populations been divided in this way.
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