The incidence of left-handedness: a meta-analysis

Beatrice M. Seddon and I.C. McManus (1993, unpublished)

This paper is probably the most cited of my unpublished manuscripts. It had a chequered publication history, some of which does not reflect well on a prestigious journal, and is probably better not described any further. For various and complex reasons it became difficult to revise the paper, and the manuscript then became somewhat dated, more studies having been published, and the was eventually left in the filing cabinet. However various people knew about it, and it has been cited on a number of occasions, most particularly by myself in the 1991 Ciba Symposium (McManus, 1991), where the two figures were also published in slightly modified form (and where 'incidence' in the title erroneously became 'inheritance').

The version presented here is based on a file on my computer dated 2nd January 1993, although there is also a somewhat modified form dated 11th October 1994. Some minor formatting has been carried out in converting a WordPerfect 5.1 file using an early version of Reference manager to a file in WordPerfect 9 with Reference Manager 9, including setting the references in APA 4 format[*]. No changes have been made to the text itself, with a single exception where a reference could not be found. The paper has been set in single spacing to help those who wish to print out the document.

I. C. McManus. The inheritance of left-handedness. In: *Biological asymcallsc38n 1 1*

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[*] Despite the file being in WordPerfect 5.1, WordPerfect 9 would not read it, and the file had to be ported through Word 97. The effect on the equations in Appendix 1 was particularly dire. Appendices 1 and 2 have therefore been scanned in from a hard copy, and their page numbers are therefore somewhat out of sequence.

The incidence of left-handedness: a meta-analysis.

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Abstract.

A meta-analysis is reported of 88 studies, examining 100 study populations, in which the handedness of 284665 individuals has been assessed. The overall incidence of left-handedness was 7.78%. The incidence of left-handedness was not related to the method of measurement, or the length or number of response items included in inventories. Study populations with lower response rates and smaller study populations showed some evidence of higher incidences of left-handedness, presumably due to response biasses. There was no evidence that the incidence of left-handedness was related to the year of publication of studies; however the incidence of left-handedness was lower in older subjects and in those from earlier birth cohorts, the two effects not being statistically distinguishable.

Information was available from 64 study populations concerning the incidence of left-handedness in males and females; overall 8.52% of males were left-handed compared with 6.69% of females, the male incidence being 27.4% higher than that in females. Although there was some suggestion that the sex difference was greater in larger studies, and in studies whose main purpose was not the study of handedness, these differences were not significant. It is concluded that the size of the sex difference is unrelated to any of the moderator variables we have studied.

It was not possible to carry out a meta-analysis of degree of handedness due to wide-spread differences in the method of reporting of degree of handedness.

We recommend that future studies of handedness should, as a minimum, use one of three standard methods of assessment, so that comparison of studies is facilitated.

(Harris, L. J. & Carlson, D. F., 1988; Soper, H. V. & Satz, P., 1984; McManus, I. C., 1983a), although the evidence in each case is weak, and not supported by evidence of similar incidences of handedness between very different cultures (Connolly, K. & Bishop, D. V. M., 1992), the statistical lack of power of studies in small remote cultures to distinguish environmental from genetic factors (McManus, I. C. & Bryden, M. P., 1993a), by the relative unimportance of intra-familial learning processes (Leiber, L. & Axelrod, S., 1981a), by the almost minimal effects of birth stress upon the incidence of handedness (Searleman, A., Porac, C., & Coren, S., 1989), and by only 5% or so of left-handers showing evidence compatible with pathological origins (Bishop, D. V. M., 1990). There is however clear evidence that left-handedness runs in families (McManus, I. C. & Bryden, M. P., 1992), and is associated with the handedness of biological rather than adoptive parents (Carter-Saltzmann, L., 1981), implying, at least in part, a genetic origin for the trait. Although many genetic models have been proposed, which have been reviewed elsewhere (McManus, I. C. & Bryden, M. P., 1992), there are at present only two potentially adequate models which can explain data from families, twins, and sex differences, the models of Annett (Annett, M., 1985), and McManus (McManus, I. C., 1985a; McManus, I. C., 1991; McManus, I. C. & Bryden, M. P., 1992). The models are similar in postulating one allele that produces 'fluctuating asymmetry' (Palmer, A. R. & Strobeck, C., 1986), a condition in which 50% of the population are right-handed and 50% are left-handed (i.e. the situation found in most non-human species), with another allele that produces a directional asymmetry in which the majority of the individuals are right-handed. The models differ in other important respects (McManus, I. C., 1985b; McManus, I. C., 1985c; McManus, I. C., Shergill, S., & Bryden, M. P., 1993), most notably in their emphasis upon the primary dimension being preference or skill asymmetries, the Annett model emphasising the primary role of skill differences, whereas the McManus model emphasises the importance of preference (McManus, I. C., 1991). Although the primacy of preference over skill is difficult to assess (Morgan, M. J. & McManus, I. C., 1988), the presence of preference asymmetry in the absence of skill asymmetry in children with autism does suggest that preference is primary (McManus, I. C., Murray, B., Doyle, K., & Baron-Cohen, S., 1992).

Considering the broad pattern of evidence on right-handedness it is possible to make a case for a strong hypothesis which suggests that right-handedness, along with the capacity to make and use tools, to use language, and to show functional and anatomical cerebral specialisation, are characteristics which together are characteristic of humans, and that they are intimately tied together in the divergent evolution of man from the apes (Frost, G. T., 1980; Calvin, W. H., 1982; Varney, N. R. & Vilensky, J. A., 1980). This divergence occurred about two and a half million years ago, perhaps as the result of a genetic mutation whereby a gene that once influenced the asymmetry of the viscera instead caused the asymmetric development of the brain, resulting in handedness and language dominance (McManus, I. C., 1991). If this hypothesis is correct then the understanding of right-handedness (and by implication, left-handedness also) is of the greatest importance for understanding the origins of humans, and for understanding the relationships between handedness and language lateralisation, and their neurobiological instantiation. Language lateralisation is intrinsically difficult to study (and even the best techniques, such as dichotic listening have relatively poor reliability and validity (Bryden, M. P., 1988a; Bryden, M. P., 1988b)). In contrast since handedness is potentially straightforward to assess in large numbers of individuals, using questionnaires or inventories, handedness represents a convenient surrogate for studying the wider aspects of cerebral lateralisation which particularly interest psychologists. A case can therefore be made that finding the gene for handedness will be the key that unlocks the neurobiology of language (McManus, I. C., 1991), and that the molecular genetics of cerebral lateralisation is a feasible objective for neuroscience (McManus, I. C. & Bryden, M. P., 1993b) incidence of left-handedness in different populations, using different measuring instruments in different ways, to determine how the methods of study and the characteristics of the subjects relate to the incidence of handedness that is found.

The incidence of left-handedness: why does it matter?.

In the majority of the population the right hand is more skilful and is preferred for use in manipulative tasks. The incidence of left-handedness has been measured in many studies, and is typically quoted as "about 10%", often with a comment to the effect that there seems to be much variation between populations (e.g. (Salmaso, D. & Longoni, A. M., 1985)), or that the method of classification is arbitrary, due to the phenomenon being distributed along a continuum (Maehara, K. et al., 1988). If a process is genetic then it is important to know whether there is significant variation between populations, either in space or in time. The absence of such variation implies the existence of a balanced polymorphism with strong selective pressures to maintain the two alleles in the gene-pool; the constraints upon a balanced polymorphism for handedness are discussed elsewhere

preference

Sampling frame. As far as was possible from the information given in each of the published studies, the method of recruitment of subjects and the possible bias in their collection was classified as follows. Particular in the case of the assessment of bias it was accepted that there was necessarily a subjective estimate in the assessment, although the two authors usually found themselves in agreement over classification.

Recruitment:

Group 1: Self-selected volunteers, who were responding as a result of their own choice (e.g. Salmaso & Longoni (, 1983a);
Group 2: A 'captive' population, representing a complete sample group, such as a whole school, (e.g. Rife (, 1940));
Group 3: A proper random population sample (e.g. Karpinos (, 1953));
Group 4: AIdinecrtmetasureent of bhndoednssm.AId somestudies, tprticular y fhors

i. Extraction of data from graphs. In several studies (Provins, K. A., Milner, A. D., & Kerr, P., 1982c; Silverberg, R., Obler, L. K., & Gordon, H. W., 1979) a frequency distribution of laterality coefficients was presented and we used that information to calculate the proportion of subjects who had laterality coefficients less than or equal to zero, that precise information not being presented in the original text.

ii. Combination of categories from the original study. Some authors presented tabular data in a more detailed form than was required for this study, and by amalgamating several categories (e.g. weak and strong right-handers (Lansky, L. M., Feinstein, H., & Peterson, J. M., 1988)) we could reduce the data to a form compatible with other studies. In a few other cases (e.g. (Newcombe, F. G. et al., 1975)) the data were presented in a unique and idiosyncratic form, and required a complete re-classification which necessarily involved some minor arbitrary decisions.

iii. Combining sub-populations. Sometimes it was convenient to combine results from a number of sub-populations which were described separately in the original studies, as for instance in combining psychology and engineering students (Jones, B. & Bell, J., 1980a), or of individuals in different geographical areas (Ardila, A. et al., 1989).

search through the back runs of journals, 30 (34%) were secondary references, cited in those studies, 10 (12%) were additional studies found in the reprint collection of one of the authors (ICM) or were unpublished studies, brief details of which are given in table 1. Some studies (Ramaley, F., 1913; Dawson, J. L. M. B., 1972) included several sets of data that could be regarded as studies of different populations (e.g. because they looked at several distinct age-groups, at different geographical areas, etc.). Not all information non-right handedness was defined as left-handers only (i.e. L/(R+M+L)) or left- and mixed handers combined (i.e. (L+M)/(R+M+L)). The median and mean rates of non-right-handedness are calculated across *study populations*, whereas the overall rate of non-righthandedness is calculated across *subjects* in the study populations, each subject contributing equally to the final figure; it is therefore weighted so that larger studies contribute more to the estimate than do smaller studies. The overall incidence is probably the best single estimate of the population incidence of left-handedness. Figure 1 shows the incidence of left-handedness in each of the 100 study populations in relation to the specific criterion used for defining left-handedness.

From table 1 it is apparent that the commonest method of assessment, L/(R+L), gives a weighted mean population incidence of 7.68%. Interestingly using a criterion of L/(R+M+L), in which mixed handers or ambidexters are included as a possible response category, gives a very similar weighted mean incidence (8.06%), in comparison with the more liberal criterion of (L+M)/(R+M+L) which gives a much higher incidence of 15.16%. The rarely used criterion of R/(R+NR) gives a somewhat higher weighted mean incidence, of 11.38%, although there are only 3 study populations with that criterion. In order to simplify further analyses in this paper we have combined three criteria, and have excluded the fourth criterion of (L+M)/(R+M+L), to give the data shown in the final row of figure 1. This gives a final overall incidence of 7.78% for the entire population, based on 284665 subjects.

Method of measurement and subjects. Table 3 shows that whether handedness is assessed by questionnaire, performance or a simple question (such as about writing hand or the handedness of the subject) has almost no effect upon the overall incidence of sinistrality ($F(4,93)=.726$, NS). In studies using a formal questionnaire or inventory, table 4 shows that there is neither an overall relationship ($F(4,47)=.122$, NS) nor a linear relationship ($F(1,47)=.141$, NS) between the number of items and the incidence of left-handedness, and table 5 shows that there is no evidence of a relationship between the number of response categories for each item and the overall incidence of sinistrality (Overall: $F(2,46)=.422$, NS; Linear $F(1,46)=.261$, NS).

In the 100 study populations, 26 (26%) used self-selected volunteers, 28 (28%) used a captive whole group of some sort, 39 (39%%) used a proper random sample and 7 (7%) consisted of left-handedness incidences reported indirectly in others from memory (e.g. parents or grandparents). The sampling method by which the subjects are obtained does seem to have some influence upon the overall incidence of left-handedness (table 6), with self-selected volunteers having a higher incidence of left-handedness than do more systematic methods of obtaining subjects, although the effect is not statistically significant ($F(3,96)=1.37$, NS); indirect reporting of others' handedness is associated with a lower rate of left-handedness, as might be expected from the results of Porac and Coren (, 1981d) also some slight difference in the incidence of left-handedness according to the source of the study; table 10 shows that the study populations obtained through a systematic random search through runs of journals had a slightly higher incidence of left-handedness than the studies obtained as references from those papers, or from a search through the

Stepwise analysis showed that only two variables were significant predictors of the proportion of left-handers, at the 0.05 level of significance. The first variable entering the equation was the age of the subjects $t(98)=-2.633$, $p=.0098$, with a slope of -1.058 % per decade (SE .4018). The second variable entered was the logarithm of the sample size ($t(97)=-2.413$, $p=.0177$), with a slope of -1.942 % per log unit. The only other variables then approaching significance for entry on the next step were the dummy for systematic search ($t(96)=1.753$, $p=.0827$) and the linear trend of bias ($t(96)=1.640$, $p=.1043$).

Since age, year of birth and year of study show some degree of multicollinearity, hierarchical analyses were conducted to find whether one was particularly important. Year of study did not seem to be of any importance, being non-significant when entered after age ($t(96)=1.54$, $p=.127$), although age was still significant when entered after year of study ($t(96)=-2.57$, $p=.0117$). Age and year of birth were each significant when entered first ($t(97)=-2.57$, $p=.0117$ and $t(97)=2.399$, $p=.0183$ respectively), although neither was significant when entered after the other ($t(96)=-1.476$, $p=.143$ and $t(97)=1.031$, $p=.305$ respectively). It must be concluded that although age is a better predictor than year of birth, this difference is of only marginal importance, and there is no sense in which age shows a significantly closer relationship than does year of birth. In contrast, year of study is significantly less correlated with the percentage of left-handedness than is age or year of birth.

Sex differences.

In 65 study populations the sex of the subjects was known, and in 63 study populations both male and female subjects were studied. Figure 2 shows, for each of those study populations, the difference in incidence of left-handedness between males and females expressed as a percentage of the incidence in females (100x(Males-variables were associated with the size of the difference in incidence in males and females.

Discussion.

This meta-analysis, which has examined the handedness of over a quarter of a million subjects, has found that overall the best estimate of the incidence of left-handedness is 7.78%, a figure remarkably close to the theoretical estimate derived from genetic studies by McManus (, 1985a), and to the value of 7.4% suggested by Coren and Porac (, 1977c) from their study of works of art over five millennia. Since completing our meta-analysis we have also become aware of the very large study of handedness by Carrothers (, 1947) which looked at 225,000 school-children in Michigan: it found an overall incidence of left-handedness of 8.2%, with a 34.3% higher incidence in males than females, both results being remarkably similar to those found in the present study.

Analysis of the incidence of left-handedness according to the type of measuring instrument suggests that there is little difference between incidences derived from lengthy, detailed inventories and from simple questions about the hand used for writing. The incidence of left-handedness therefore seems to be robust across measurement methods. One possible source of bias concerns the size and the response rate of studies: smaller studies, and those with lower response rates have somewhat higher incidences of left-handedness, possibly because left-handers are more likely to respond in such situations, as has been demonstrated by Cornell and McManus (, 1992). A similar difference is found in studies in which handedness is manifestly the purpose of the study, as compared with those in which it is merely one variable amongst many others. Stepwise regression suggests that the latter effect is mainly secondary to the effect of study size.

Of particular theoretical interest for understanding the origins of left-handedness is our finding of a lack of obvious difference in the incidence of handedness as a function of the continent in which they live. A genetic theory in which handedness was under strong selective pressure, being maintained by a balanced polymorphism, would expect such a result.

The differences between age groups and birth cohorts are difficult to interpret, in the absence of clear data suggesting that one effect is secondary to the other. This failure probably reflects a poor power of our study, with only 100 studies, to distinguish such effects. Either the age or the year of birth effect could be interpreted as older subjects (who tend to be born earlier), and who have lower incidences of left-handedness, being subject to greater degrees of reporting bias, for one reason or another. Alternatively there may be genuine differences in handedness between age groups or birth cohorts. Studies comparing the influence of age upon hand preferences for different tasks suggest that some tasks, such as picking up a glass show trends towards greater right-hand usage than do tasks such as writing a letter or cutting with scissors (Porac, C., Izaak, M., & Rees, L., 1990), suggesting that social or other pressures may be partly responsible for age-related changes. Within right-handers there is also evidence that the degree of handedness, as assessed by a peg-board task, becomes greater with age (Weller, M. P. I. & Latimer-Sayer, D. T., 1985). Taken together these results allow the possibility that apparent age-related or cohort-related changes in incidence of handedness may reflect differences in interpretation of questions, or of different criteria for self-description as right or left-handed. There is a striking absence of adequate longitudinal studies of adult handedness, but we suspect that they would show that the direction of adult handedness is relatively fixed (although its degree may well change). Taken together we do not feel at present that the effects of age upon handedness are sufficient to support the controversial hypothesis of Halpern and Coren (, 1990b) that left-handers have an increased mortality compared with right-handers, and hence are less prevalent in older age groups. A principal reason for being sceptical of that result is that in the data of

problem would be avoided if studies were to report the results of measures of degree of handedness in a standardised form.

In general we were impressed by the results of the larger studies of handedness simply because the studies had of necessity used fairly straightforward measures of handedness, and had a high response rate because of the method of sampling; examples that particularly come to mind are those of the Scottish scholastic survey (Scottish Council for Research in Education, 1953) in school children, of Komai and Fukuoka (, 1934), also in schoolchildren, and of Karpinos and Grossman (, 1953) in servicemen. We must therefore recommend that in general unless degree of handedness or some detailed analysis of specific items is the particular interest of studies, that simple, easily interpretable questions should be used.

In the interests of further analysis of handedness we therefore recommend that the following methods of measuring and reporting handedness are used, wherever possible. They are described in detail, along with scoring methods, in Appendix 1.

Recommendations on the measurement of handedness.
a. Handedness should be assessed and reported using one of the following methods:

A laterality quotient (LQ) should be calculated in the conventional manner, and then results presented in terms of particular bands of scores. We recommend that simple left- and right-handedness should be defined as $LQ \leq 0$ and $LQ > 0$ respectively. Degree of handedness should always be presented by categorising subjects as weak or strong right-and left-handers. If it is wished to sub-divide categories further then this should be done by dividing these groups into two (to give eight equal categories),etc., so that it is then possible to recombine groups for comparison across studies. In addition means and Sds of laterality quotients can be reported, in which case they should be reported separately for right and left-handers (defined as $LQ > 0$ and $LQ \leq 0$ respectively). The overall mean and SD of the laterality quotient do not provide useful information since they confound direction and degree of handedness.

b. In all studies the incidence of handedness should be reported separately for males and females, using whatever method of assessment has been decided upon.

c. Distributions of laterality coefficients are useful only as an additional form of reporting of incidences; they should not be used as a substitute for the methods described above.

Appendix 1: Recommended methods of measuring handedness.

For each method the manner of calculation of the proportion of left-handers (pL) is indicated, along with the method of calculating the proportion of weak left-handers (pWL), weak right-handers (pWR) and weak handedness overall (pW). Whatever method of assessment is used, results of studies should always be reported separately for males and females.

Method i.a: "Which hand

[illegible]	[illegible]
'Right'	R
'Left'	L

$$pL=\frac{L}{R+L}$$

cannot be calculated.

Method i.b: "Which hand do you normally use for writing?"

Responses	*Number of replies*
'Always right'	R
'Usually right'	r
'Either'	e
'Usually left'	l
'Always left'	L

Scoring All studies should report pL, pWR,

$$pL=\frac{L+l+e}{R+r+e+l+L}$$

$$pWR=\frac{r}{r+R}$$

$$pWL=\frac{l}{l+L}$$

$$pW=\frac{r+e+l}{R+r+e+l+L}$$

For each subject calculate a laterality

$$pL = \frac{n(LQ \leq 0)}{N}$$

$$pWR = \frac{n(50 > LQ > 0)}{n(LQ > 0)}$$

Appendix 2: Recommended handedness inventory.

Handedness inventory

Please indicate your preferences in the use of a hand for the following activities by putting a tick in the appropriate column.

Some of the activities require both hands. In these cases the part of the task or

to answer all the questions and only leave a blank if you have no experience at all of the object or task.

	Always Left	Usually Left	Either	Usually Right	Always Left
1. Writing					
2. Drawing					
3. Throwing		I			I
4. Scissors					
5. Toothbrush					
6. Knife (without fork)					
7. Spoon					
8. Broom (upper hand)					
9. Striking match					
10. Opening box (holding the lid)					

Table 1: A summary of the studies included in the meta-analysis.

Study	Subjects

(Table continued)

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(Table continued)

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Study	Subjects	How found	Estimated bias	Response rate	Assessment method	Handedness criterion	Final category	Sub-groups	%Left-handed: Total	Males	Females
		universities									
Dawson, 1972 (Dawson, J. L. M. B., 1972)	95 Aborigines; 204 Sierra Leone Temnes	Random sample	3	-	Performance of 3 tasks (writing, receiving object, cutting)	2 or more items L	R-L	Aborigines Temnes	10.5 3.4	10.7 3.8	5.9 0.0

(Table continued)

26

		Oxfordshire villages									
Annett, 1976 (Annett, M., 1976)	804 British students	Captive whole group; class at Open University summer1c 479.28 0.72 0.72 re f 140.64 479.28 0.72 0.72 re f 140.64 4.1.12 0.72 8.88 re f BT 218.7252.88 0.72 12.96 re f BT 2.7252.88 0.72 12.96 re 287.2.72									

(Table continued)

Micle, S., & Arensburg, B., 1978)					handed?'			North Africa R North Africa R+M Europe R Europe R+M	10.4 13.3 16.2	10.4 13.3 16.2	- - -
Peters, 1986 (Peters, M., 1986)	5910 Canadian children	Captive whole group of schools in 3 different districts	2	100%	Writing hand	Writing hand	R-L	-	11.0	11.9	10.0
Searleman, Tweedy and Springer, 1979 (Searleman, A., Tweedy, J., & Springer, S., 1979b)	847 American students	Captive whole group of university students	3	-	'Are you R/L handed?'	Answer to question	R-M-L	L L+M	13.5 16.5	13.8 17.2	13.3 16.1
Silverberg, Obler and Gordon, 1979 (Silverberg, R., Obler, L. K., & Gordon, H. W., 1979)	1171 Israeli children										

(Table continued)

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Written questionnaire	LQ < 0	R-L	-	11.8	13.5	9.9

Writing hand	Writing hand	R-L	Parents Children	7.1 10.5	7.1 11.9	7.1 9.1

[redacted]

Shimizu and Endo, 1983 (Shimizu, A. & Endo, M., 1983)	4282 Japanese students	Random sample of five senior schools	2	96%	Written questionnaire	Laterality score	R-NR	-	11.0	12.0	10.011.011.0Spiegler, B. J. &

(Table continued)

31

		day									
McManus, 1985 (McManus, I. C., 1985a) - ICM1	613 British students and relatives	Self-selected volunteers at university, who also reported on siblings and parents	3	50%	Writing hand	Writing hand					

(Table continued)

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(Chapman, L. J. & Chapman, J. P., 1987)	students	psychology students at a university			e						
Chapman, Chapman and Allen, 1987 (Chapman, J. P., Chapman, L. J., & Allen, J. A., 1987)	311 American students	Randomly selected psychology students at a university	3	-	Written questionnair e	Laterality score	R-L	-	20.3	-	-
Payne, 1987 (Payne, M. A., 1987)	201 Nigerian students										

(Table continued)

33

(Levander, M. & Schalling, D., 1988)		at a college									

(Table continued)

Table 2: the overall incidence of left-handedness in the studies.

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[redacted] f assessment of handedness.

[redacted]	Males	Females	Overall incidence: Males	Overall incidence: Females	100(M-F) / -------- / F

[redacted]

Table 4: Incidence of left-handedness in relation to number of items on questionnaire or inventory.

Number of items on questionnaire	Number of studies	Number of subjects	Median

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Table 5: Incidence of left-handedness in relation to number of response categories on each item of an inventory.

Number of response categories on questionnaire	Number of studies	Number of subjects	Median	Mean	Overall incidence	Males	Females	Overall incidence: Males	Overall incidence: Females	100(M-F) -------- F
<5	20	51599	9.0	9.14	8.79	23127	21926	9.72	7.83	24.1
5	27	33033								

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Table 6: Incidence of left-handedness in relation to sampling method for obtaining subjects.

Sampling methods	Number of studies	Number of subjects	Median	Mean	Overall incidence	Males	Females	Overall incidence: Males	Overall incidence: Females	100(M-F) -------- F
Self-selected volunteers	26	28897	9.8	10.31	10.02	10701	10879	10.80	8.99	20.1

Table 7: Incidence of left-handedness in relation to estimated degree of bias in the selection of subjects.

Estimated degree of bias	Number of studies	Number of subjects	Median	Mean	Overall incidence	Males	Females	Overall incidence: Males	Overall incidence: Females	100(M-F) / F
None	10	101443	7.1	6.95	6.04	50682	50036	7.09	4.94	43.5
Slight	42	121862	9.1	9.01	8.55	61822	46312	9.22	7.92	16.4
Possible	35	47607	9.1	9.07	8.79					

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Table 9: Incidence of left-handedness in relation to sample size in study.

Sample size

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Table 10: Incidence of left-handedness in relation to source of study.

Source of study	Number of studies	Number of subjects	Median	Mean	Overall incidence	Males	Females	Overall incidence: Males	Overall incidence: Females	100(M-F) -------- F
Systematic search	48	79630	9.1	10.30	9.16	24106	24991	10.49	8.75	19.9
Secondary references	34	176816	7.8	8.01						

Table 12: Incidence of left-handedness in relation to the year in which the study was carried out (or year of publication if year of study not stated).

Year of study or year of publication	Number of studies	Number of subjects	Median	Mean	Overall incidence	Males	Females	Overall incidence: Males	Overall incidence: Females

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Table 13: Incidence of left-handedness in relation to estimated year of birth of subjects.

Year of birth	Number of studies	Number of subjects	Median	Mean	Overall incidence	Males	Females	Overall incidence: Males	Overall incidence: Females	100(M-F) -------- F
Pre-1910	8	27697	4.9	6.43	4.65	13355	11005	4.58	3.36	36.3
1910-39	10	39573	7.8	8.11	9.36	25827	11585	9.71	9.02	7.6
1940-59	26	115129	9.8	8.78	6.41					

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Table 15: Incidence of left-handedness in relation to geographical region of study.

Continent	Number of studies	Number of subjects	Median	Mean	Overall incidence	Males	Females	Overall incidence: Males	Overall incidence: Females	100(M-F) / F

F

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F

Table 16. Degree of handedness in 2028 applicants to medical school (McManus, 1986, unpublished). Applicants were asked to state the hand used for writing on a five-point scale.

Classification	Males	Females	Chi-square
Always Right	968 (87.5%)	774 (83.9%)	
Usually Right	15 (1.4%)	47 (5.1%)	
Either	3 (0.3%)	3 (0.3%)	
Usually Left	6 (0.5%)	9 (1.0%)	
Always Left	114 (10.3%)	89 (9.7%)	
Total	1106	922	

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Figure 1:

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Figure 2: Shows the difference in incidence of handedness in male and females for 62 study populations. The percentage excess of left-handedness in males is calculated as 100*(M-F)/F.

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