

Review Article

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Laterality and otorhinolaryngology: a review

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Abstract

Background. Laterality of paired organs involves the function of the eyes, ears, hands and feet. Whilst most people have a right-handed preference, about 10 per cent are left-handed. Similarly, the right eye is usually preferred to the left. Medicine is both taught and practised for those with right hand and eye preference, and left-handed medical students and doctors must negotiate the right-handed world.

Objective. This brief review looks at society's attitudes, medical training and the practice of otorhinolaryngology in the UK towards laterality and handedness.

Method. Literature review.

Results. Studies suggest that left-handers are more versatile and so are more ambidextrous. Conversely, this may result in problems when a right-hander tries to undertake a procedure with the non-dominant hand.

Conclusion. Cultures and attitudes are changing towards those who are left-handed. Left-handed surgeons may encounter difficulties in the clinical environment throughout their training.

Introduction

Left-handedness has long been considered an evil trait, derived from its Latin origin 'sinister', meaning left. Although left-handers may be more prone to head trauma,¹ unintentional injuries² and dyslexia,³ they are also considered more artistic, musical and creative.^{3,4} The prevalence of left-handedness is thought to be roughly 10 per cent of the general population, with a slightly higher tendency in males.⁵

The world we live in is very much adapted for the right-handed person,⁶ for example, the vehicles we drive (no change in foot pedals between left- and right-hand drives), machinery and tools, and work-place environments are all geared towards right-handed people. Within the surgical setting, although left-handed instruments exist, many left-handers adapt to the way of the right-hander, and their left-handedness is suppressed in the operating theatre. The prevalence of left-handed surgeons coincides with that of the general population.⁷

The National Health Service relies on employees from all over the world to help staff it, and so beliefs and training will vary. In the UK, medicine has changed greatly over the last 50 years. Even so, best practice still follows the process of history-taking, examination, likely diagnoses and subsequent investigations. These aid in the advice and treatment that patients receive. In surgical specialties, good manual and eye skills are required. In otorhinolaryngology, we have seen the introduction of fibre-optic endoscopy, computed tomography and magnetic resonance imaging, as well as widespread use of information and image technology, and robotic surgery. Change affects each specialty differently.

A recent article highlighted the problems that right-handed surgeons have when using scissors with the left hand.⁸ As the majority of the population, including doctors, are right-handed and have been for many generations,⁹ they perhaps take too much for granted and give little thought to those who are different. Whatever the medical changes, those who prefer to use the left hand or eye must negotiate a somewhat alien world. Much has been written on laterality outside of medicine, particularly handedness, which has been well reviewed in several books.^{10,11} Here, we summarise varying aspects of laterality.

Attitudes

Attitudes to left-handedness, which is of course only one aspect of human laterality, have eased over the last 100 years in the developed world. In previous generations, there was considerable pressure to conform and to use the right hand to write. Jimi Hendrix may well have written with that hand, but could any right-hander play naturally the inverted electric guitar like he did? There is a tendency to oversimplify, which must be resisted, or at the very least be understood. The quoted figure of 10 per cent left-handed prevalence will vary depending on sample size and when handedness was measured, as well as attitudes to handedness. This variation is reflected in studies of hand usage rather than preference in the older population, where the pressure to conform was higher.

The causes of handedness are multifactorial, but it is thought to occur more than expected in some families.¹² Of the second author's immediate family and their partners ($n = 19$ in three generations) there are six who have a left-handed preference (1:3). In the first author's immediate family and partners ($n = 13$), there are four left-handers (prevalence of 1:3).

Laterality and usage

The preference of a paired organ, eye, ear, foot or hand varies naturally from adult to adult. Even the simplest task, for example throwing a ball, requires the use of the hand, eye, balance and co-ordination. The right eye, ear, foot and hand may dominate in some. It is natural to ask if there is an association between eye and hand preference, for example, although the central processing for the task is complex, and it must integrate sensory inputs and motor functions.

As mentioned, the dominance of the right-handed world is easy to recognise: the layout of a mobile telephone, the position of a mouse on a desk, the buttons of a Bluetooth headset on the right speaker and the exit of an electrical cable on the left speaker to leave the right hand unencumbered. Even an adult who has strong preference for the right hand may listen to the telephone with the left ear and hold the telephone with the non-dominant hand. An electric drill spins clockwise as this makes it easier for the right-handed members of both sexes to use. Many left-handers utilise a mixed-handed approach as they negotiate this world.

Measuring hand preference scientifically is fraught with difficulties, as learnt usage and the input of other paired organs confound. When listening to music, an individual may subconsciously tap one foot. Early footage of the four Beatles shows the two right-handers, John Lennon and George Harrison, tapping time with different feet: John used his left whereas George used his right. Even posture is affected, for when sitting, the legs may be crossed with the preferred leg on top. Although laterality is more complex than handedness, emphasis on handedness extends into customs and beliefs that may well influence how life is interpreted.

Laterality and culture

Some societies are less developed materially and hold different cultural beliefs. In such societies, a hand dips into the communal food bowl. The skin around an emptied bowl is cleaned with the contralateral hand, whilst custom dictates that the right hand is used for feeding and the left for cleaning, even if a left-hander naturally does the opposite. Use of the left hand is discouraged, and such attitudes may extend to left-handed surgeons.¹³

Each side of the body may be given a moral value. The right is 'good' and the left is 'bad' or 'evil', and such views are found from antiquity. The Hamsa, an amulet of the right hand, warded off the evil eye. The dichotomy of left and right extends into political ideology: right, for conservatism and left, for change.

When writing using the Latin (or Roman) alphabet, accepted practice is to move from left to right. This is also true when evaluating information on a graph, or a comic strip. This is contrary to Chinese characters, which begin at the top right and descend the page from right to left. In all different forms of writing, the implement is pulled by the right hand and pushed by the left. Theories surrounding the

directionality of languages are lacking in evidence, although in East Asian languages, traditionally recorded on bamboo scrolls, it was easier to write top to bottom and right to left, with the left hand managing the bamboo. As Middle Eastern languages favoured stone, chiselling right to left was thought to be easier. With the use of ink in modern-day society, moving left to right as a right-hander prevents smudging.¹⁴ Left-handed writing is still forbidden in some cultures.

The fewer characters of the Latin alphabet facilitated both printing and the widespread literacy that occurred in Europe. Colonial expansion was aided by technology produced by the Industrial Revolution. Now, English is the current language of science. With the advent of technology, a computer keyboard permits the use of both hands for typing, and dictation software overcomes the limitations of many different languages and scripts. In addition, the introduction of the electronic patient record is making handwriting redundant, potentially taking away this challenge for the left-hander.

Laterality and sensory input

Eyes

Visual impairment occurs in around 2.4 per 1000 children in the UK, and although most visual conditions in childhood are relatively minor, just under 10 per cent have disorders, for example strabismus, amblyopia and hypermetropia.¹⁵ Having an eye condition is thought to be associated with a lower household socioeconomic status, reduced birth weight and prematurity.¹⁵

Ears

Hand laterality develops during the first few years of life. It is usually clear by the age of three years and continues to develop after this point.¹⁶ Adapted adult tests of observed behaviour, and more precise measures of strength, speed, accuracy and precision, address different but overlapping aspects of the degree of handedness. As most adults are right-handed, inherent preference in left-handed children is difficult to assess, as learning confounds.

The problem is worse in the ears, as comprehension may be required and surrogate measures are considered, for example speech development. The literature on ear preference is sparse and has been reviewed by Clare Porac.¹¹ Roughly two-thirds of right-handers prefer their right ear, and two-thirds of left-handers prefer their left ear or have mixed preference.¹¹ Both eyedness and earedness seem to be more complicated than limb preference, likely because of the more complex hemispheric connections.

About 2 per 1000 children are born with some sensorineural hearing loss.¹⁷ This is profound in both ears in less than 5 children in 10 000.¹⁸ Middle-ear problems are common in childhood and affect about 30 per cent of the paediatric population.¹⁹ Until the advent of antibiotics, many children were left with perforated tympanic membranes following acute otitis media. Otitis media with effusion is perhaps more common now than acute otitis media and its sequelae, and usually resolves before the age of 10 years, although surgical intervention is sometimes a necessity.

A review of young children with acute otitis media showed that children with bilateral disease, when compared to unilateral acute otitis media, are more likely to be younger, have more inflammation of the tympanic membrane and be more

susceptible to bacterial infection.²⁰ With regard to laterality, it is recommended that bilateral acute otitis media is treated more aggressively, using antibiotic therapy.

The National Institute for Health and Care Excellence guidelines advise only that bilateral secretory otitis media should be treated surgically.²¹ This does not consider laterality, as a child may well be handicapped if the preferred ear is affected. In adults with acute sensorineural hearing loss, both sexes are equally affected.²² It is slightly more common in the right ear in males and the left in females. In one study on benign paroxysmal positional vertigo, disease was more common in the right ear (82 out of 142) and there was a significant association between affected ear and the head-lying side during sleep (with 97 out of 142 in favour of sleeping on their right side).²³ This is in contrast to research on Ménière's disease and sudden sensorineural hearing loss, where acute sensorineural hearing loss was more common in the left ear.²⁴ It is difficult to draw any conclusions from the relevant published work.

Laterality and learning

It would be straightforward to explain laterality if the brain were programmed this way, but there seem to be multiple factors at play. It is easy to focus on one aspect of laterality, for example hand preference, and link it to another issue, for example the ability to read fluently. Dyslexia is more complicated than a simple link, as there is a visual element as well as central processing. Even so, being left-handed has been connected over the years to children with special needs, stuttering and stibismus.^{25–27} In adults, it has been associated with criminality, alcoholism, heavy smoking, epilepsy, asthma, autoimmune conditions, cancers and social deprivation.^{28–31}

Clinical environment

The clinic room is set up for the right-eye dominant and right-handed doctor.³² A bull's eye lamp was commonly found in the otolaryngology clinic over the past few decades, whereby a parallel light source originated from behind the left shoulder of the patient. The parabolic head mirror had a focal length of 7 inches (18 cm), which allowed the clinician to move freely around the clinic and to use both hands, but the mirror had a central hole positioned for the right eye to use. A headlight gets around this limitation, and when powered by a battery, it overcomes the restriction of the light box. However, when an otoscope is used, it is customary to hold it with the left hand for the left ear, and the right hand for the right ear: eye preference is not important.

In the past, the laryngoscope or mirror used to view the post-nasal space was held with the right hand, and the tongue was covered in a gauze swab and held with the left hand. Patients often found this unpleasant, and views were incomplete. Modern endoscopes (both rigid and flexible) often include a camera attachment for an image to be portrayed on an adjacent screen. Eye preference is therefore not important, but the controls are usually set up for right-handed use. In practice, this means that far fewer direct laryngoscopies are now required in the operating theatre.

When a monocular microscope is used, a right-hander might well prefer to use the left eye. Even in medicine, binocular operating microscopes are usually set up for the right eye. When the teaching arm or camera is attached, it is usually on the right side.

Whilst there are left-handed instruments, these are not commonly found within UK operating theatres or clinical environments. Most instruments are made for the right hand, and the floor pedals are usually placed for right-foot usage. The problem with using scissors with the left hand has been mentioned, and many left-handed surgeons have developed manoeuvres to cut sutures.⁸

Medical training and handedness

Training and practice appear to differ around the world for hand usage. When sutures are tied by hand, both hands are used to tie the knot. In the UK, otolaryngologists are expected to not cross their hands to allow an adequate view. This is particularly pertinent in a tonsillectomy procedure, where the left hand is used for the dissection and diathermy application for the left tonsillectomy, and the right hand for the right side. This is also relevant to endoscopic laryngeal surgery, where there is relative symmetry with regard to anatomy. Hand choice is often dictated by the laterality of the lesion, as opposed to handedness or preference, to obtain sound surgical results. In one study of simulated endoscopic laryngeal surgery performed by 19 surgeons, of whom 1 was left-handed, it was demonstrated that in only a third of the cases was the non-dominant hand used appropriately.³³

Kim *et al.*'s study on the incidence of intra-operative complications in cataract surgery performed by left-handed residents revealed that although left-handed residents ($n = 3$) performed 9.2 per cent ($n = 170$) of the operations over a five-year period, they had a statistically significantly lower rate of complications.³⁴ Several theories exist to explain this finding, including better use of the right hand when required, or that left-handed surgeons may just be more talented. Although this is a bold, generalised claim to make, years of suppression and having to conform may mean that left-handed surgeons, when allowed to flourish in the perfect environment, could be naturally more technically gifted.

One study on psychomotor skills comparing left- and right-handed medical students found little difference between them.³⁵ The study of 27 students in each group compared suturing skills, cannulation techniques, urinary catheterisation and laparoscopic skills. The only difference was in laparoscopic peg removal, which was performed more quickly by the left-handers, but both groups completed the task in the targeted time.

There is a need for ambidexterity in laparoscopic surgery. A study of 16 trainees found that the 4 left-handed trainees used their right hand frequently. These four trainees were able to use both hands better and had a shorter operating time compared with those who were right-handed.³⁶

One study compared 50 right- and 50 left-handers using the O'Connor tweezer dexterity test.³⁷ This compared the time taken to complete a task using both hands sequentially, and showed that left-handers performed significantly better and had a greater degree of ambidexterity than right-handers (97.2 vs 71.6 per cent congruity). The authors' summary that 'these results suggest that any perceived difference between left-handed and right-handed surgical residents may not be due to innate skill or dexterity, but rather a combination of external influences' rings true to what we have summarised so far in this review.

In addition, Mehta and Lotke reviewed the outcomes of total knee replacements performed by a right-handed surgeon, where the surgeon stood to operate on the ipsilateral side, and

found poorer outcomes associated with left total knee replacement compared to right total knee replacement.³⁸ This further qualifies that external influences could be causation for a worse outcome.

With regard to otology surgery, a small retrospective study investigated whether the results of surgery performed on ipsilateral and contralateral ears were similar for both left and right-handed surgeons. Only surgeon experience was associated with shorter operative times and a slightly better hearing outcome (although these findings were not statistically significant).³⁹

A literature search published in 2010 revealed 19 studies on handedness and surgical training, and although many were in the form of surveys, numerous issues were apparent. A lack of mentoring, anxiety for both trainers and trainees, and the need for a trainee to have a degree of ambidexterity were observed.⁴⁰ Additionally, trainers can become impatient, and do not know how to train a left-handed trainee.⁴¹

Handedness and ENT conditions

Otolaryngologists treat a range of conditions, from rare genetic diseases to commonly acquired ones. The relationship between dextrocardia and ciliary dysfunction has been explored.^{42,43} The conclusion is that there is probably no relationship between left-handedness and situs inversus or ciliary dysfunction. Moreover, in patients with situs inversus requiring abdominal surgery, the laparoscopic approach is much more ergonomic and comfortable, with ambidexterity employed by the left-handed surgeon.⁴⁴ Much more common is otitis externa: the dominant hand scratches the external ear, and in patients with necrotising otitis externa, there is a strong correlation between handedness and affected side.⁴⁵ The same has also been shown to be true for acquired cholesteatoma.⁴⁶ Carcinoma of the external ear is rare, but habitual ear picking is common in Japan. Again, there is some evidence that handedness is related to side of the carcinoma.⁴⁷ Tinnitus, noise-induced hearing loss and acoustic trauma are more common on the left side, but do not seem to be related to handedness.^{48,49}

Conclusion

Attitudes and cultures are changing, although the world we live in is very much designed for the right-handed person. The prevalence of left-handedness in both the general population and in medicine shows no significant difference, possibly implying that although the clinical environment is more adapted to a right-handed doctor, this scenario is not off-putting for those who are left-handed. In addition, the left-handed surgeon is not without skill, and is perhaps more skilled when it comes to undertaking procedures, but there are external and environmental factors to consider. Left-handed trainees, although more likely to be ambidextrous, will possibly continue to struggle when supervised by right-handed trainers. We must recognise this issue by mentoring and providing training solutions before problems are encountered.

Competing interests. None declared.

References

1 Macniven E. Increased prevalence of left-handedness in victims of head trauma. *Brain Inj* 1994;**8**:457–62

- 2 Coren S. Left-handedness and accident-related injury risk. *Am J Public Health* 1989;**79**:1040–1
- 3 Götestam KO. Lefthandedness among students of architecture and music. *Percept Mot Skills* 1990;**70**:1323–7
- 4 Schachter S, Ransil B. Handedness distributions in nine professional groups. *Percept Mot Skills* 1996;**82**:51–63
- 5 Papadatou-Pastou M, Ntolka E, Schmitz J, Martin M, Munafò MR, Ocklenburg S *et al.* Human handedness: a meta-analysis. *Psychol Bull* 2020;**146**:481–524
- 6 McManus C. Left–right discrimination in medicine. *BMJ* 2008;**337**:1426–7
- 7 Lancer H, Lancer J. Aiding right-hand dominant surgeons in left-handed use of scissors. *Bull R Coll Surg Engl* 2022;**4**:107
- 8 Al Hussainy HA, See A. Aiding right-hand dominant surgeons in left-handed use of scissors. *Bull R Coll Surg Engl* 2022;**104**:38–42
- 9 Schott J, Puttick M. Handedness among surgeons. *BMJ* 1995;**310**:739
- 10 Smits R. *The Puzzle of Left-handedness*. London: Reaktion Books, 2011
- 11 Porac C. *Laterality: Exploring the Enigma of Left-Handedness*. London: Academic Press, 2016
- 12 McManus IC. The inheritance of left-handedness. *Ciba Found Symp* 1991;**162**:251–67
- 13 Zaghoul MS, Saquib J, Al-Mazrou A, Saquib N. A qualitative assessment of the impact of handedness among left-handed surgeons in Saudi Arabia. *Laterality* 2018;**23**:39–50
- 14 Why Some Languages Are Written Right To Left. In: <https://www.thesaurus.com/e/writing/righttoleft#:~:text=East%20Asian%20languages%2C%20it's%20suggested,the%20left%20managing%20the%20paper> [9 June 2023]
- 15 Cumberland PM, Pathai S, Rahi JS. Prevalence of eye disease in early childhood and associated factors: findings from the Millennium Cohort Study. *Ophthalmology* 2010;**117**:2184–90
- 16 Scharoun SM, Bryden PJ. Hand preference, performance abilities, and hand selection in children. *Front Psychol* 2014;**5**:82
- 17 Deltenre P, Van Maldergem L. Hearing loss and deafness in the pediatric population: causes, diagnosis, and rehabilitation. *Handb Clin Neurol* 2013;**113**:1527–38
- 18 Smith RJH, Bale JF, White KR. Sensorineural hearing loss in children. *Lancet* 2005;**365**:879–90
- 19 Bluestone CD, Shurin PA. Middle ear disease in children: pathogenesis, diagnosis, and management. *Pediatr Clin North Am* 1974;**21**:379–400
- 20 McCormick DP, Chandler SM, Chonmaitree T. Laterality of acute otitis media: different clinical and microbiologic characteristics. *Pediatr Infect Dis J* 2007;**26**:583–8
- 21 Otitis media with effusion in under 12s: surgery. In: <https://www.nice.org.uk/guidance/CG60/chapter/Recommendations#children-who-will-benefit-from-surgical-intervention-2> [30 June 2023]
- 22 Reiss M, Reiss G. Laterality of sudden sensorineural hearing loss. *Ear Nose Throat J* 2014;**93**:318–20
- 23 Korres SG, Papadakis CE, Riga MG, Balatsouras DG, Dikeos DG, Soldatos CR. Sleep position and laterality of benign paroxysmal positional vertigo. *J Laryngol Otol* 2008;**122**:1295–8
- 24 Heermann J. Predominance of left ear in Menière's disease, sudden deafness, inner ear damage, tinnitus and abnormally patent eustachian tube. *Ear Nose Throat J* 1993;**72**:205–8
- 25 Kushner HI. Retraining left-handers and the aetiology of stuttering: the rise and fall of an intriguing theory. *Laterality* 2012;**17**:673–93
- 26 The art of medicine. In: [https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736\(11\)60854-4.pdf](https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(11)60854-4.pdf) [9 June 2023]
- 27 Tønnessen FE, Løkken A, Høien T, Lundberg I. Dyslexia, left-handedness, and immune disorders. *Arch Neurol* 1993;**50**:411–16
- 28 Bogaert A. Handedness, criminality, and sexual offending. *Neuropsychologia* 2001;**39**:465–9
- 29 Denny K. Handedness and drinking behaviour. *Br J Health Psychol* 2011;**16**:386–95
- 30 Harburg E, Feldstein A, Papsdorf J. Handedness and smoking. *Percept Mot Skills* 1978;**47**:1171–4
- 31 Zverev YP, Chisi J. Is handedness related to health status? *Malawi Med J* 2004;**16**:14–16
- 32 Drake-Lee A. It's all about coordination and laterality. *BMJ* 2009;**338**:34
- 33 Naunheim MR, Le A, Dedmon MM, Franco RA, Anderson J, Song PC. The effect of handedness and laterality in a microlaryngeal surgery simulator. *Am J Otolaryngol* 2017;**38**:472–4

- 34 Kim JY, Ali R, Cremers SL, Yun SC, Henderson BA. Incidence of intraoperative complications in cataract surgery performed by left-handed residents. *J Cataract Refract Surg* 2009;**35**:1019–25
- 35 Alnassar S, Alrashoudi AN, Alaqeel M, Alotaibi H, Alkahel A, Hajjar W *et al*. Clinical psychomotor skills among left and right handed medical students: are the left-handed medical students left out? *BMC Med Educ* 2016;**16**:97
- 36 Nagaraj MB, AbdelFattah KR, Farr DE. Laparoscopic ambidexterity in left-handed trainees. *J Surg Res* 2022;**275**:203–7
- 37 Lombana NF, Naeger PA, Padilla PL, Falola RA, Cole EL. Ambidexterity in left-handed and right-handed individuals and implications for surgical training. *Proc (Bayl Univ Med Cent)* 2022;**35**:176–9
- 38 Mehta S, Lotke PA. Impact of surgeon handedness and laterality on outcomes of total knee arthroplasties: should right-handed surgeons do only right TKAs? *Am J Orthop (Belle Mead NJ)* 2007;**36**:530–3
- 39 Barzaga G. The relationship of surgeon handedness and experience on operative duration and hearing improvement in ipsilateral and contralateral otologic surgeries. *Philippine J Otolaryngol Head Neck Surg* 2020;**35**:17
- 40 Tchantchaleishvili V, Myers P. Left-handedness: a handicap for training in surgery? *J Surg Educ* 2010;**67**:233–6
- 41 Lieske B. The left handed surgical trainee. *BMJ* 2008;**337**:2883
- 42 Afzelius BA, Stenram U. Prevalence and genetics of immotile-cilia syndrome and left-handedness. *Int J Dev Biol* 2004;**50**:571–3
- 43 McManus IC, Davison A, Armour JAL. Multilocus genetic models of handedness closely resemble single-locus models in explaining family data and are compatible with genome-wide association studies. *Ann N Y Acad Sci* 2013;**1288**:48–58
- 44 Oms L, Badia J. Laparoscopic cholecystectomy in situs inversus totalis: the importance of being left-handed. *Surg Endosc* 2003;**17**:1859–61
- 45 Migirov L, Lipshitz N, Dagan E, Wolf M. Is laterality of malignant otitis externa related to handedness? *Med Hypotheses* 2013;**81**:142–3
- 46 Migirov L. Laterality of acquired cholesteatoma and handedness. *Otol Neurotol* 2012;**33**:996–7
- 47 Tsunoda A, Sumi T, Terasaki O, Kishimoto S. Right dominance in the incidence of external auditory canal squamous cell carcinoma in the Japanese population: does handedness affect carcinogenesis? *Laryngoscope Investig Otolaryngol* 2017;**2**:19–22
- 48 Reiss M, Reiss G. Laterality of tinnitus: relationship to functional asymmetries [in German]. *Wien Klin Wochenschr* 2001;**113**:45–51
- 49 Nageris B, Raveh E, Zilberberg M, Attias J. Asymmetry in noise-induced hearing loss: relevance of acoustic reflex and left or right handedness. *Otol Neurotol* 2007;**28**:434–7