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Musical Hallucinations
A Historical and Clinical Study

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A sample of 46 subjects experiencing musical hallucinations was analysed – 10 new cases in addition to 36 culled from the literature. When compared with controls, it was found that musical hallucinations are far more common in females, and that age, deafness, and brain disease affecting the non-dominant hemisphere play an important role in their development. Psychiatric illness and personality factors were found to be unimportant.

The concepts

Hallucinations are speech acts reporting putative sensory experiences, believed to be causally unrelated to external stimuli (Ey, 1973; Johnson, 1978; Berrios, 1985). They may involve any sense modality. Auditory hallucinations, particularly voices, are common, and their diagnostic relevance is made to depend upon phenomenology (e.g. content), attributed origin, relationship to brain disease, and presence of insight (Hécaen & Ropert, 1959; Lowe, 1973; Junginger & Frame, 1985; Asaad & Shapiro, 1986; Slade & Bentall, 1988). Musical hallucinations are less common, and hence there are not enough empirical data to evaluate their role in diagnosis (Morsier, 1938; Hécaen & Ropert, 1963; Ross *et al*, 1975; Ross, 1978). Their rarity may reflect a fact of nature, but under-reporting is likely to play a role. Musical hallucinations are found at the cross-roads of otological, neurological, and psychiatric practice.

In general, what clinicians mean by 'musical hallucinations' is the hearing of tunes or melodies. This is a rather restricted view, as the concept of music also includes harmonics, rhythms, and timbres. Hence, when pure rhythms are hallucinated, clinicians might hesitate to call them musical hallucinations. In other words, it is easy to decide that a subject is having a musical hallucination if he reports hearing "God save the Queen"; it is less so if he reports hearing a piece by Stockhausen or von Webern. This is not just quibbling with words for, if musical hallucinations are to be causally related to brain sites (Gardner *et al*, 1977; Marin, 1982; Pribram, 1982; Zatorre, 1984), it is of the essence to know whether processing of information relating to melody, harmony, rhythm, and timbre occurs in a common locus.

Since a musician is likely to report as 'music' hallucinatory experiences far more complex than the hearing of a ditty, the general reporting of musical hallucinations may be influenced by the level of the sufferer's musical training. The latter is also likely to influence the clinician's diagnosis of the site of the lesion, as there is some evidence that representation of musical information shifts with training from the non-dominant to the dominant hemisphere (Bever & Chiarello, 1974).

Clinical aspects

Musical hallucinations may be experienced in a variety of clinical situations which include disease of the ear (Petazzi, 1900), neurological (Penfield & Perot, 1963) and psychiatric pathology (Aizenberg *et al*, 1986), and toxic states (Victor & Hope, 1958; Malitz *et al*, 1962; Allen, 1985). Depending on the aetiology, onset may be acute or gradual, and the experience may or may not be accompanied by insight or delusional elaboration. Musical hallucinations may be the only complaint or be part of a constellation of noises (e.g tinnitus) which have usually heralded their appearance. The noises can 'mature' (as with alcoholic hallucinosis) and become complex sound forms or tunes (Hécaen & Ropert, 1963). In the case of deaf individuals, musical hallucinations may disintegrate after a time, to be replaced by short and iterative musical phrases, like the noise made by a scratched record, which cause, as a rule, psychological distress. When associated with strokes or depressive illness, musical hallucinations tend to disappear *pari passu* with the underlying pathology.

Historical aspects

The history of the current concept of hallucinations starts in the early 1800s (Berrios, 1982), and that of musical hallucination in the 1880s. Although references to deaf patients hearing voices (Esquirol, 1838) or music (Baillarger, 1846; Griesinger, 1867) can be found in the medical literature since the early 19th century, psychiatrists seem to have been less interested in them than ear specialists. Thus, Erhard

(1868), the great ENT pioneer, suggested various loci for these 'subjective auditory sensations': sensation of beat or pulsation, internal carotid; murmurs or bruits, vestibule; songs and music, cochlea; and bruits and tinnitus, the acoustic nerve.

So, when the psychiatrist Régis (1881) became interested in the association between hallucinatory experiences and peripheral sensory defects (particularly of hearing and vision), he already had a hypothesis to test. His own view was that musical hallucinations resulted from positive and negative changes in the sensory pathways: positive changes (e.g. tinnitus) gave rise to noise (the '*point de repére*') which served as the point around which the musical hallucination was to crystallise; negative changes (e.g. deafness) contributed by creating a state of deafferentation. To explain why musical hallucinations were so rare, in spite of the fact that deafness and tinnitus were so common, Régis (1896) was forced to introduce covariates such as age and personality 'traits'.

During this period, psychological and organic hypotheses were available to explain the origin of hallucinations. Unilateral musical (and other auditory) hallucinations were considered, however, as indicating an organic (peripheral) aetiology (Robertson, 1881, 1901; Toulouse, 1892; Lugaro, 1904; Tanabe *et al*, 1986). After reviewing the evidence available, Toulouse (1892) concluded that a peripheral lesion alone could not explain the laterality of auditory hallucinations, and suggested that a cortical lesion was also required. Thus, a debate started as to whether personality or cortical factors were more important, and Lugaro (1904) and other members of the Italian school (Otonello, 1930) stood firmly for the former. Régis (1896) felt that both may be important, and was later to suggest that presence of insight might serve to characterise those musical hallucinations that had organic as opposed to psychotic origin. Soon after, Claude & Ey (1932) re-opened the aetiological debate and described the so-called 'organic hallucinosis' syndrome, which they considered to be unrelated to psychotic hallucinations. Musical hallucinations were included in the former (Ey, 1973).

Method

Some 91 cases of musical hallucinations have been reported (Baillarger, 1846; Parish, 1897; Petazzi, 1900; Robertson, 1901; Politzer, 1926; Keschner *et al*, 1936; L'Hermitte & Parcheminey, 1943; David *et al*, 1944, 1945; Paillas & Subirana, 1950; Mulder & Daly, 1952; Rosanski & Rosen, 1952; Victor & Hope, 1958; Kleist, 1962; Malitz & Esecover, 1962; Shurley, 1962; Ahlenstiel, 1963; Penfield & Perot, 1963; Ross *et al*, 1975; Clovis, 1976; Ross, 1978; Miller & Crosby, 1979; Raghuram *et al*, 1980; Gilchrist & Kalucy, 1983; Hammeke *et al*, 1983; Sacks, 1985; Jonas, 1986; Patel *et al*, 1987). Reports of cohorts, providing no individual clinical details, mention another 44 (Scott, 1975). Of the 91 cases, only 36 contain sufficient clinical data to support statistical analysis (Régis, 1896; Petazzi, 1900; Keschner *et al*, 1936; Morsier, 1938; L'Hermitte & Parcheminey, 1943; David *et al*, 1944, 1945; Mulder & Daly, 1952; Rosanski & Rosen, 1952; Hécaen & Ropert, 1963; Penfield & Perot, 1963; Ross *et al*, 1975; Miller & Crosby, 1979; Raghuram, 1980; Gilchrist & Kalucy, 1983; Hammeke *et al*, 1983; Allen, 1985; Sacks, 1985; Aizenberg *et al*, 1986; Jonas, 1986; Patel *et al*, 1987). To these, ten new ones (six examined personally) have been added. The 46 resulting cases constitute the sample, 'Index 1'.

The variables recorded in each case include age, sex, laterality of the lesion, ear disease, deafness, brain disease, insight, psychiatric illness, ability of the subject to modify the hallucinations, content of the musical hallucination, and other accompanying hallucinations.

For the purposes of analysis and comparison, subjects with musical hallucinations who were also deaf (31 out of 46) were made into a subsample, 'Index 2'. Five control samples were also included: Control 3, 44 subjects with visual hallucinations (Berrios & Brook, 1985); Control 4, 90 subjects with presbyacusis; Control 5, 38 subjects with tinnitus; Control 6, 207 subjects with inner-ear disease (Berrios *et al*, 1988); and Control 7, 21 subjects with visual hallucinations and advanced impairment of vision (Berrios & Brook, 1985).

In addition, the sample of 69 patients with epilepsy and 'experiential' hallucinations reported by Penfield & Perot (1963) was analysed statistically as 21 of these patients had, in fact, experienced musical hallucinations, either spontaneously or after cortical stimulation.

Data were analysed on a IBM PC-AT computer by means of the SPSS/PC V2 package (Norusis, 1988).

Results

Clinical features for the 46 cases are shown in Table I. Noteworthy are the marked predominance of females (80%), and the age of the group (mean 60, s.d. 19 years); 32% of subjects experienced lateralised hallucinations, and in 62% the onset was gradual; 67% were deaf; and in 40% musical hallucinations were the only symptom. The latter proved to be mainly constituted by subjects with strokes, tumours, or epileptic foci, without deafness or psychiatric history. Songs, whether accompanied by instruments or *a cappella*, were the most common form of hallucination, religious and patriotic hymns being quite popular.

Hallucinations tended, in general, to be heard most of the time, either as alternating tunes or as a repeating musical phrase. Gradual fragmentation of melodies was described in nine cases, and there was a tendency for it to correlate with duration of the disease, but this effect did not reach statistical significance. Insight (present from the start or soon gained) was present in 73% of subjects. There was no psychiatric history in 74% of subjects; this variable included both past history of mental illness and concomitant

TABLE I
Characteristics of 46 subjects experiencing musical hallucinations

Sex	
female	37
male	9
Age: years	
men	
mean	55.8, s.d. 21
median	52
women	
mean	61.0, s.d. 18.8
median	64
Lateralisation	
bilateral	31
right	8
left	7
Type of onset	
acute	17
gradual	29
Modifiable	
yes	6
no	30
unknown	10
Predominant	
instrumental	18
singing	26
bird songs	2
Insight	
yes	33
no	13
Ear disease[1]	
present	29
absent	16
Deafness	
present	31
absent	15
Other hallucinations[2]	
tinnitus	16
voices	11
visual	3
absent	18
Psychiatric disorder	
yes	12
no	34

1. No information in one report.
2. Total does not add up to 46 as some hallucinations overlapped

TABLE II
Associated brain pathology

Temporal lobe tumour	6 (5 right, 1 left)
EEG temporal foci[1,2]	5 (3 right, 1 left)
Stroke	3 (3 right)
Neurosyphilis	2
Subarachnoid haematoma	1
Localised 'atrophy'	1
Behçet's syndrome	1
Brain injury (traffic accident)	1
Induced by electroconvulsive therapy	1
None found or reported	28[3]

1. There was underlying pathology in three cases: stroke in 2 and tumour in 1.
2. One case bilateral foci.
3. Cases do not add up to 46 for there was some overlap in pathology.

TABLE III
Significant intra-group correlations

	Age	*Onset (acute)*	*Other hallu-cinations*	*Brain disease*	*Psychiatric disease*
Deafness	0.46	−0.49		−0.49	
Ear disease			0.41		
Onset (gradual)			0.48	−0.47	
Insight				0.44	−0.51

All values, $P<0.01$ (Bonferroni corrected)

TABLE IV
Principal component analysis (12 variables)

Factor extracted	*Eigenvalue*	*Cumulative variance (%)*
ENT disorder	3	25
Brain disease	1.7	41
Psychiatric disorder	1.4	54
Music	1.3	66

mental illness – in the case of the latter, depression accounted for most of the variance. Of the ten new cases, six were seen in neurological or ENT wards. In 39% of the whole sample there was evidence of brain disease; tumours, epileptic foci, and strokes (sited in the right temporal lobe) were common (Table II).

There was a significant correlation (after Bonferroni correction (Table III) between age and deafness ($k=0.46$), and subjects with musical hallucinations of acute onset tended not to be deaf but had brain disease. Patients affected by ear disease tended to experience other forms of hallucinations, mainly tinnitus and humming, of gradual onset. Those with brain disease tended to have insight; those with psychiatric disease did not.

Table IV shows the results of an exploratory factor analysis of the Index 1 sample. It accounted for 66% of the variance and extracted four factors: ENT disorder, brain disease, psychiatric disorder, and music. A discriminant function was then obtained by Wilks' method (comprising male, no deafness, acute onset, no psychiatric disease, no other hallucination) which could classify correctly 89% of the sample as having 'brain disease' ($P<0.001$). The discriminant function profiled subjects who were (a) male, and who had (b) no deafness, (c) musical hallucinations of acute onset, (d) unaccompanied by any other form of hallucination, and (e) no psychiatric disease.

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TABLE V
Musical hallucinations in index and control samples

Samples	*Clinical content of sample*	*Number*	*Age: years (s.d.)*		*Female/male*	*Source of comparative data*
Index						
1	Total	46	60.9	(19)	37/9	This study
2	With deafness	31	66	(17)	26/5	This study
Control						
3	Visual hallucinations	44	77.1	(13.2)	27/17	Berrios & Brook (1985)
4	Presbyacusis	90	74	(10)	45/45	Berrios *et al* (1988)
5	Tinnitus	38	52	(13)	20/18	Berrios *et al* (1988)
6	Inner-ear disease	207	61	(21)	98/109	Berrios *et al* (1988)
7	Visual impairment	21	73.2	(9.5)	14/7	Berrios & Brook (1985)

Comparisons for age (*t*-test, two-tailed)

Comparison	Value	Significance
1v.3 =	7.9	$P<0.01$
1v.4 =	12.4	$P<0.01$
1v.5 =	4.13	$P<0.01$
1v.6 =	0.06	NS
2v.4 =	3.42	$P<0.01$
2v.7 =	1.84	NS

Comparisons for sex (χ^2)

Comparison	Value	Significance
1v.3 =	2.87	NS
1v.4 =	9.64	$P<0.01$
1v.5 =	5.72	$P<0.05$
1v.6 =	13.8	$P<0.01$
2v.7 =	2.3	NS

TABLE VI
Statistical analysis of sample reported by Penfield & Perot (1963)

No. of cases	69
Male/female	35/34
Age: years	
mean	27 (s.d. 9)
median	26
mode	19
Side of lesion	
right	33
left	36
Tumour	
present	18
absent	51
Atrophy/gliosis	
present	48
absent	21
Musical hallucinations	
present	21
absent	48
spontaneous[1]	9
induced	12

1. Female preponderance, $P<0.05$ (Fisher's exact test)

Table V shows the results of comparing the two index samples with the five control groups (3–7). Patients with musical hallucinations were significantly younger than patients with visual hallucinations, presbyacusis, and tinnitis. There was a significant difference in sex ratios, with more females among the subjects with musical hallucinations than among those with presbyacusis or tinnitus.

Table VI shows the results of the statistical analysis performed on the sample reported by Penfield and Perot (1963). As expected, they constituted a much younger sample and 30% had experienced at least one musical hallucination (only 42% had been spontaneous). A significant predominance of women (Fisher's exact test, $P<0.05$) was also found when only the subjects who had experienced spontaneous musical hallucinations were considered.

Clinical vignettes

These have been chosen from the ten new cases to illustrate *specific* forms of presentation or clinical course.

Case 1

A 56-year-old woman, the wife of a school headmaster, secretary of a local branch of the Women's Institute, had a history of hypertension but not of psychiatric illness. She collapsed while walking her dog. In hospital she was found to be confused, and had left hemiparesis. Computerised tomography showed an infarction on the right temporal lobe. She intimated that she 'might be going mad', as she was hearing religious hymns, which were persistent and grew worse when she plugged her ears with cottonwool. There was no evidence of peripheral ear disease or deafness. The hallucinations resolved six weeks later. Her stroke left no obvious neurological sequelae.

Case 2

An 81-year-old lady, sprightly, living with a friend, had no evidence of cognitive impairment but had marked deafness; there was no family or personal history of psychiatric illness. She heard the voice of an imaginary companion in addition to her persistent musical hallucinations. The patient was found to have a right temporal focus on electroencephalography (EEG). There was marked attenuation of the hallucinations after treatment with carbamezapine (plasma levels 43 mmol/l).

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Case 3

A 75-year-old married woman, with a history of depression, an absence of deafness or brain disease, continuously heard "Away in the Manger" and other Christmas carols. She was found to be depressed. She was treated with antidepressants and neuroleptics and took her own discharge. Her general practitioner later reported that she was much better.

Case 4

A 46-year-old man, with no family or personal history of psychiatric illness, who was bright and articulate, developed severe deafness after a viral infection of the inner ear. He was suicidal and treated successfully for depression. Three years later he developed tinnitus, which was worse on the right side; he began intermittently to hear a popular song as if through headphones. He felt for a time reassured that his hearing might be coming back, but once again he became depressed, with early-morning wakening; treatment with phenelzine and chlorpromazine gave good results.

Case 5

An 86-year-old woman, married, with severe deafness, had no personal or family history of psychiatric illness, and had worked as an executive secretary in the City for 40 years. She had become completely deaf ten years previously, although had rehabilitated fully. During the last five years she had developed tinnitus, and then began to hear tunes and songs from the 1920s. Amused and entertained by the music, she only complained when her hallucinations broke up into short musical phrases (like a scratched record). To alleviate her discomfort she would try to sing along with her musical hallucinations. EEG showed a right temporal focus. She responded badly to carbamezapine and was discharged six months later unchanged.

Case 6

A 79-year-old woman who had been hearing singing and music for about a year had, a few weeks before psychiatric referral, begun to hear voices telling her to move house and kill herself. On examination she was found to be deaf, depressed, with early awakening, and some suicidal thoughts; she had been taking amphetamines for about 25 years (started as treatment for depression). She recovered on trifluoperazine, tailing off the amphetamines. The voices disappeared completely but she could still hear music. On follow-up three years later she could still hear music but was untroubled by it.

Discussion

Caution must be exercised in the interpretation of data of mixed provenance. This must not be allowed, however, to obscure the fact that the sample of subjects with musical hallucinations reported in this paper is probably the largest thus far, and also that the variables chosen for the analysis were robust and reliable.

The most salient findings have been that musical hallucinations seem to be more frequently in elderly women affected by deafness, or by brain disease, and with no history of psychiatric illness.

Before the predominance of women is accepted as a genuine finding, it is important to rule out sampling artifacts (the female pool available to develop musical hallucinations is larger because females live longer), or the intervention of mediating variables (e.g. deafness, epilepsy, brain tumour). Comparison with the various control groups showed that age does not seem to be an important factor (no difference with presbyacusis or tinnitus). Furthermore, female predominance was also found in the much younger sample reported by Penfield & Perot (1963). With regard to the intervention of a mediating variable, there is no evidence that epilepsy (Neugebauer & Susser, 1979; Dam *et al*, 1985), deafness (Eastwood *et al*, 1985), tinnitus (Shulman, 1981), or brain tumours (Zulch, 1965; Jones, 1986; Lovaste *et al*, 1986; Sutherland *et al*, 1987) are more prevalent in females, nor that auditory hallucinations are more frequent in females with schizophrenia at any age (Koehler *et al*, 1977; Bettes & Walker, 1987).

It is, however, interesting to note that there was also a predominance of females in a group of elderly people experiencing visual hallucinations (Berrios & Brook, 1985). It must therefore be concluded that there may be a tendency for women to experience (or to report) hallucinosis (i.e. hallucinations related to organic states) more often than men. This conclusion cannot be extended, however, to hallucinations in general (i.e. voices in schizophrenia). On the basis of the information in hand, it is unwarranted to speculate as to the mechanisms involved in this finding. It may be that women report their experiences more often, or that the finding indeed reflects differences in lateralisation (Waber, 1976; Levy, 1978).

Other findings reported in this paper confirm views already expressed in the literature, namely that deafness (Ross, 1978), ear disease (Bryant, 1907), advanced age (Berrios & Brook, 1982), drugs (Victor & Hope, 1958; Allen, 1985), and brain disease (Penfield & Perot, 1963) are important factors in the generation and persistence of musical hallucinations.

With regard to laterality of the lesion, in the case of subjects with tumours, strokes or epileptic foci, the indication is that the non-dominant hemisphere plays an important role. This finding fits in well with what is known about music processing in the brain (Critchley & Henson, 1977; Clynes, 1982; Zatorre, 1984; Marin, 1982; Gardner *et al*, 1977). It also

suggests a dissociation between musical hallucinations and the putative mechanisms linked to hallucinatory voices in schizophrenia which, as expected, seem to be related to the dominant hemisphere (Bazhin *et al*, 1975; Trimble, 1987).

This paper has little to say with regard to the differential diagnosis of musical hallucinations, except that, occasionally, subjects with true palinacusis (Jacobs *et al*, 1973; Malone & Leiman, 1983) (like the second case of Hécaen & Ropert (1963)) might be misdiagnosed as suffering from genuine musical hallucinations.

Conclusions

Musical hallucinations are rare. They seem to be more common in women and this sexual predominance is unlikely to have resulted from sampling bias. Ear disease, deafness, and brain disease seem to play a major role in their aetiology. Brain disease tends to affect, as neuropsychology would dictate, the right or non-dominant hemisphere. It is likely the factors such as psychosis and personality traits play only a minimal role in the development of most musical hallucinations.

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References

AHLENSTIEL, H. (1963) Den Sinnengedachtnis-Erscheinungen nahestehende, langdauernde akustische Halluzinationen. *Archiv für Psychiatrie*, **204**, 86–95.

AIZENBERG, D., SCHWARTZ, B. & MODAI, I. (1986) Musical hallucinations, acquired deafness and depression. *Journal of Nervous and Mental Diseases*, **174**, 309–311.

ALLEN, J. R. (1985) Salicylate-induced musical perceptions (letter). *New England Journal of Medicine*, **313**, 642–643.

ASAAD, G. & SHAPIRO, B. (1986) Hallucinations: theoretical and clinical overview. *American Journal of Psychiatry*, **143**, 1088–1097.

BAILLARGER, M. J. (1846) Des Hallucinations. *Memoires l'Academie Royale de Medecine*, **12**, 273–475.

BAZHIN, E. F., WASSERMANN, L. I. & TONKONOGII, I. M. (1975) Auditory hallucinations and left temporal lobe pathology. *Neuropsychologia*, **13**, 481–487.

BERRIOS, G. E. (1982) Tactile hallucinations: conceptual and historical aspects. *Journal of Neurology, Neurosurgery and Psychiatry*, **45**, 285–293.

—— & BROOK, P. (1982) The Charles Bonnet syndrome and the problems of visual perception in the elderly. *Age and Ageing*, **11**, 17–23.

—— & —— (1985) Visual hallucinations and sensory delusions in the elderly. *British Journal of Psychiatry*, **144**, 662–664.

——, RYLEY, J. P., GARVEY, T. P. N., *et al* (1988) Psychiatric morbidity in subjects with inner ear disease. *Clinical Otolaryngology*, **13**, 259–266.

BETTES, B. A. & WALKER, E. (1987) Positive and negative symptoms in psychotic and other psychiatrically disturbed children. *Journal of Child Psychology and Psychiatry*, **28**, 555–568.

BEVER, T. G. & CHIARELLO, R. J. (1974) Cerebral dominance in musicians and non-musicians. *Science*, **185**, 537–539.

BRYANT, W. S. (1907) De la grande importance psychique des affections d'oreilles. *Archives Internationales de Laryngologie, Otologie, et Rhinologie*, **23**, 85–98.

CLAUDE, H. & EY, H. (1932) Evolution des ides sur l'hallucination. Position actuelle du probleme. *L'Encephale*, **27**, 362–377.

CLOVIS, W. L. (1976) They hear music (letter). *American Journal of Psychiatry*, **133**, 1096.

CLYNES, M. (ed.) (1982) *Music, Mind, and Brain. The Neuropsychology of Music*. New York: Plenum Press.

CRITCHLEY, M. & HENSON, R. A. (eds) (1977) *Music and the Brain. Studies in the Neurology of Music*. London: William Heinemann.

DAM, A. M., FREDERIKSEN, A. F., OLSEN, U. S., *et al* (1985) Late-onset epilepsy: etiologies of seizure, and value of clinical investigation, EEG, and computerized tomography scan. *Epilepsia*, **26**, 227–231.

DAVID, M., HÉCAEN, H. & COULONJOU, R. (1944) Hallucinations auditives sans délire par affections neurologiques. *Annales Médico-Psychologiques*, **102**, 139–143.

——, COULONJOU, R. & HÉCAEN, H. (1945) Equivalents comitiaux de type hallucinatoire divers, uniques symptomes d'une tumeur temporal gauche. *Annales Médico-Psychologiques*, **103**, 93–97.

EASTWOOD, M. R., CORBIN, S. L., REED, M., *et al* (1985) Acquired hearing loss and psychiatric illness. An estimate of prevalence and co-morbidity in a geriatric setting. *British Journal of Psychiatry*, **147**, 552–556.

ERHARD, T. (1868) Report on Meeting of Berlin Medical Society. *Archives Générales de Médecine*, **12**, 374–379.

ESQUIROL, J. E. D. (1838) *Des Maladies Mentales considerées sous les rapports medical, hygienique et médico-legal*. Paris: J. B. Baillèire.

EY, H. (1973) *Traité des Hallucinations*. Paris: Masson et Cie.

GARDNER, H., SILVERMAN, J., DENES, G., *et al* (1977) Sensitivity to musical denotation and connotation in organic patients. *Cortex*, **13**, 242–256.

GILCHRIST, P. N. & KALUCY, R. S. (1983) Musical hallucinations in the elderly: a variation on the theme. *Australian and New Zealand Journal of Psychiatry*, **17**, 286–291.

GRIESINGER, W. (1867) *Mental Pathology and Therapeutics* (trans. C. L. Robertson & J. Rutherford). London: New Sydenham Society.

HAMMEKE, T. A., MCQUILLEN, M. P. & COHEN, B. A. (1983) Musical hallucinations associated with acquired deafness. *Journal of Neurology, Neurosurgery, and Psychiatry*, **46**, 570–572.

HÉCAEN, H. & ROPERT, R. (1959) Hallucinations auditives au cours de syndromes neurologiques. *Annales Médico-Psychologiques*, **117**, 257–306.

—— & —— (1963) Les hallucinations auditives des otopathes. *Journal de Psychologie Normale et Pathologique*, **60**, 293–324.

JACOBS, L., FELDMAN, M. & DIAMOND, S. P. (1973) Palinacusis: persistent or recurring auditory sensations. *Cortex*, **9**, 275–282.

JOHNSON, F. H. (1978) *The Anatomy of Hallucinations*. Chicago: Nelson Hall.

JONAS, W. R. (1986) Akustische Halluzinose bei Schwerhorigkeit. *Nervenarzt*, **57**, 252–254.

JONES, R. D. (1986) Epidemiology of brain tumours in man and their relationship with chemical agents. *Food and Chemical Toxicology*, **24**, 99–103.

JUNGINGER, J. & FRAME, C. L. (1985) Self-report of the frequency and phenomenology of verbal hallucinations. *Journal of Nervous and Mental Diseases*, **173**, 149–155.

KESCHNER, M., BENDER, M. B. & STRAUSS, I. (1936) Mental symptoms in cases of tumour of the temporal lobe. *Archives of Neurology and Psychiatry*, **35**, 572–596.

KLEIST, K. (1962) *Sensory Aphasia and Amusia. The Myelo-architectonic Basis* (trans. F. J. Fish & J. B. Stanton). Oxford: Pergamon Press.

KOEHLER, K., GUTH, W. & GRIMM, G. (1977) First-rank symptoms of schizophrenia in Schneider-oriented German centers. *Archives of General Psychiatry*, **34**, 810–813.

L'HERMITTE, J. & PARCHEMINEY, M. (1943) Sur une complication exceptionnel de l'electro-shoc: l'hallucination musicale. *Revue Neurologique*, **75**, 37–38.

LEVY, J. (1978) Lateral differences in the human brain in cognition and behavioural control. In *Cerebral Correlates of Conscious Experience* (eds P. Buser & A. Rougeul-Buser). New York: North Holland.

LOVASTE, M. G., FERRARI, G. & ROSSI, G. (1986) Epidemiology of primary intracraneal neoplasms. *Neuroepidemiology*, **5**, 220–232.

LOWE, G. R. (1973) The phenomenology of hallucinations as an aid to differential diagnosis. *British Journal of Psychiatry*, **123**, 621–633.

LUGARO, E. (1904) Sulle allucinazioni unilaterali dell'udito. *Rivista di Patalogia Nervosa e Mentale*, **9**, 229–237.

MALITZ, S., B. & ESECOVER, H. A. (1962) Comparison of drug-induced hallucinations with those seen in spontaneously occurring psychoses. In *Hallucinations* (ed. L. J. West), pp. 50–63. New York: Grune & Stratton.

MALONE, G. L. & LEIMAN, H. I. (1983) Differential diagnosis of palinacusis in a psychiatric patient. *American Journal of Psychiatry*, **140**, 1067–1068.

MARIN, O. S. M. (1982) Neurological aspect of music perception and performance. In *The Psychology of Music* (ed. D. Deutsch), pp. 453–477). New York: Academic Press.

MILLER, T. C. & CROSBY, T. W. (1979) Musical hallucinations in a deaf elderly patient. *Annals of Neurology*, **5**, 301–302.

MORSIER, G. DE. (1938) Les hallucinations. Etude oto-neuro-ophthalmologique. *Revue d'Oto-Neuro-Ophthalmologie*, **16**, 241–352.

MULDER, D. W. & DALY, D. (1952) Psychiatric symptoms associated with lesions of the temporal lobe. *Journal of the American Medical Association*, **150**, 173–176.

NEUGEBAUER, R. & SUSSER, M. (1979) Epilepsy. Some epidemiological aspects. *Psychological Medicine*, **9**, 207–215.

NORUSIS, M. J. (1988) *SPSS/PC+ V2.0 Base Manual*. Chicago: SPSS Inc.

OTONELLO, P. (1930) Sull'importanza dei disturbi uditivi in patologia mentale. *Rivista di Patologia Nervosa e Mentale*, **35**, 351–414.

PAILLAS, J.-E. & SUBIRANA, A. (1950) Semeiologie neuro-psychiatrique. *Revue d'Oto-neuro-Ophthalmologie*, **22**, 123–218.

PARISH, E. (1897) *Hallucinations and Illusions. A Study of the Fallacies of Perception*. London: Walter Scott.

PATEL, H. C., KESHAVAN, M. S. & MARTIN, S. (1987) A case of Charles Bonnet syndrome with musical hallucinations. *Canadian Journal of Psychiatry*, **32**, 303–304.

PENFIELD, W. & PEROT, P. (1963) The brain's record of auditory and visual experience – a final summary and discussion. *Brain*, **86**, 595–696.

PETAZZI, A. (1900) Contributo allo studio delle allucinazione acustische specialmente in rapporto colle alterazione dell'apparato uditivo periferico. *Archivio Italiano di Otologia, Rinologia e Laringologia*, **10**, 385–429.

POLITZER, A. (1926) *Textbook of the Diseases of the Ear* (6th edn) (rewritten by M. J. Ballin). New York: MacMillan.

PRIBAM, K. H. (1982) Brain mechanisms in music. In *Music, Mind and Brain. The Neuropsychology of Music* (ed. M. Clynes), pp. 21–35. New York: Plenum Press.

RAGHURAM, R., KESHAVAN, M. D. & CHANNABASAVANNA, S. M. (1980) Musical hallucinations in a deaf middle-aged patient. *Journal of Clinical Psychiatry*, **41**, 357.

RÉGIS, E. (1881) Des hallucinations unilaterales. *L'Encéphale*, **1**, 43–74.

—— (1896) Les hallucinations unilaterales et la pathologie des hallucinations. In *Comptes Rendus des 7° Congrés des Alienistes et Neurologistes de Langue Française*, pp. 23–33. Nancy: Housseau.

ROBERTSON, A. (1881) On unilateral hallucinations and their relation to cerebral localization. In *Transactions of the International Medical Congress* (ed. W. MacCormac), pp. 632–633. London: Kolckman.

—— (1901) Unilateral hallucinations: their relative frequency, associations, and pathology. *Journal of Mental Science*, **47**, 276–293.

ROSANSKI, J. & ROSEN, H. (1952) Musical hallucinosis in otosclerosis. *Confinia Neurologica (Basle)*, **12**, 49–54.

ROSS, E. D. (1978) Musical hallucinations in deafness revisited (letter). *Journal of the American Medical Association*, **240**, 1716.

——, JOSSMAN, P. B., BELL, S., *et al* (1975) Musical hallucinations in deafness. *Journal of the American Medical Association*, **231**, 620–621.

SACKS, O. (1985) *The Man who Mistook his Wife for a Hat*. London: Duckworth.

SCOTT, R. T. (1975) Hallucinations of music in alcohol withdrawal. *Neurology*, **25**, 362.

SHULMAN, A. (1981) Subjective idiopathic tinnitus: a review. *Journal of Laryngology*, **4**, 1–9.

SHURLEY, J. T. (1962) Hallucinations in sensory deprivation and sleep deprivation. In *Hallucinations* (ed. D. J. West), pp. 87–91. New York: Grune & Stratton.

SLADE, P. D. & BENTALL, R. P. (1988) *Sensory Deception. A Scientific Analysis of Hallucination*. London: Croom Helm.

SUTHERLAND, G. R., FLORELL, R., LOUW, D., *et al* (1987) Epidemiology of primary intracranial neoplasms in Manitoba. *Canadian Journal of Neurological Sciences*, **14**, 586–592.

TANABE, H., SAWADA, T., ASAI, J., *et al* (1986) Lateralization phenomenon of complex auditory hallucinations. *Acta Psychiatrica Scandinavica*, **74**, 178–182.

TOULOUSE, E. (1892) Les hallucinations unilaterales. *Gazette des Hopitaux Civils et Militaire*, **65**, 609–618.

TRIMBLE, M. R. (1987) The neurology of schizophrenia. *British Medical Bulletin*, **43**, 587–598.

VICTOR, M. & HOPE, J. M. (1958) The phenomenon of auditory hallucinations in chronic alcoholism. *Journal of Nervous and Mental Diseases*, **126**, 451–481.

WABER, D. (1976) Sex differences in cognition: a function of maturation rate? *Science*, **192**, 572–573.

ZATORRE, R. J. (1984) Musical perception and cerebral function: a critical review. *Music Perception*, **2**, 196–221.

ZULCH, K. J. (1965) *Brain Tumours, Their Biology and Pathology*. New York: Springer-Verlag.

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