mask but the sounds persisted. Neurological and neurosurgical opinion was sought. Thioridazine and temazepam were prescribed. The benzodiazepine helped to modify the sound slightly and lessen its intensity. However, the musical sounds continued to plague her waking life and the "hallucinations" triggered a psychiatric referral.

At the first psychiatric interview, the patient referred to the book "The Man who mistook his wife for a hat" by Oliver Sacks.[1] She mentioned that her son had heard a description of this book on the radio including several examples of patients described therein. One of these was the case of a medical oddity which struck him as having similar features to those of his mother. They acquired the book and the patient recognised that her problem was similar to the "musical reminiscence" (see[1], chapter 15).

In the five years since the onset of her symptoms, the musical sounds heard by the patient have not ceased during her waking hours apart from a brief period of a few hours several months after the onset. At the time of her psychiatric referral, the sounds were phrases from folk songs and non verbal sounds, for example "Highland Laddie ta ra ra, Bonnie Laddie". Subsequently the words became less distinct and more of a tuneful humming. Much to her annoyance, the sounds she experienced were often slightly out of tune. Shortly after the start of her illness, she gained full insight into her problem and from that point recognised that the tunes were from within her mind rather than originating in external space. She was not found to have any features of psychiatric illness. During her psychiatric contact she hinted at suicide if no resolution of her problem could be found but at no time did she appear to be suffering from a depressive illness.

Pharmacological treatments with haloperidol, thioridazine, benzodiazepines, carbamazepine and sodium valproate were tried but without any success.

A psychometric assessment concluded that she was above average intelligence and that there were "no pointers to suggest the right hemisphere dysfunction which has been inferred in some published cases of this disorder". In 1988 a further EEG showed intermittent irregular sharp and slow wave complexes in anterior-mid temporal regions, maximal on the right side though frequently bilateral.

An MRI scan in October 1988, showed multiple small areas of abnormal signal scattered throughout both hemispheres. A SPECT scan in February 1989 was normal.

The unusual symptom of formed auditory hallucinations of a musical nature are rare in the medical literature, with only three dozen cases fully reported[2] and none giving details of NMR or SPECT studies. There was a longstanding notion that hallucinations are to be equated with schizophrenia but this is clearly unfounded and hallucinations are never pathognomonic of any given disorder.[3]

In most of the reported cases, there are certain common features. These are amplified in a definitive review.[2] The patients are generally elderly and often have a history of progressive deafness over the previous decade. The deafness may be a contributory factor as external noise would be diminished allowing for an emphasis on the internally generated hallucinatory sounds. As in the case of our patient, Hammeke *et al*[4] described how the auditory hallucinations of their two patients were affected by ambient noise levels and the content and speed of the hallucinations were influenced by attentional and intentional factors. They postulated that a combination of peripheral and associated central "disinhibition" may be responsible for the occurrence of such hallucinations.

The prognosis is largely unknown. In many cases the symptoms last until death. On the whole, patients are able to adjust to the symptoms and find their own individual methods of shutting out the noise, for example, turning up the radio, trying to ignore it mentally or occupying themselves with a range of activities. Benzodiazepines seem to be useful in alleviating the insomnia. Our patient (and many of the reported cases) gained immense relief when they were assured there was no evidence of psychiatric illness and they were not "going mad" as they had feared.

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Pituitary hormones in relation to magnetic stimulation of the brain

There has been considerable interest in the technique of stimulating the central motor pathways with a brief high intensity magnetic field.[1] This form of transcranial stimulation causes less discomfort than the electrical technique described previously, making it feasible to study function in central motor pathways in children. Although no adverse effects have been reported in adults,[2] it is essential to collect further information about possible effects on cerebral function before this technique can be used routinely on children. A previous study of transcranial electrical stimulation in adults did not show any EEG changes or rise in prolactin, but the numbers of stimuli were limited by the discomfort of stimulation.[3] The reduction in discomfort related to magnetic stimulation might well lead to large numbers of stimuli being used. It was therefore decided to carry out a study in normal adults to measure any possible effects of transcranial magnetic stimulation (at clinically relevant levels of testing) on plasma concentrations of pituitary hormones and EEG.

Transcranial magnetic stimulation was carried out on 17 healthy adult volunteers aged 21 to 66 years (6 males and 11 females). The subjects were not receiving any medication, and informed consent was obtained in all cases. The study was approved by the Ethical Committee.

The subjects were fasted overnight and an indwelling venous catheter was inserted at least 15 minutes before stimulation. Two blood samples were taken before stimulation (−15 minutes and time zero). Seven further samples were taken at 10, 20, 30, 45, 60, 75 and 90 minutes after the beginning of magnetic stimulation. In 11 subjects (all females aged 21 to 58 years) a control investigation using a dummy coil was carried out on a different day, the order of testing being randomised. The dummy coil was held over the subject's head while the active coil was discharged, with its characteristic "crack", away from and out of sight of the subject. Blood sampling was repeated as described above, taking care to carry out measurements in each individual at the same time of day to minimise the effects of diurnal variation.

Growth hormone (GH), prolactin (PL), and cortisol were measured in all samples. Luteinising hormone (LH), follicle stimulating hormone (FSH) and thyroid stimulating hormone (TSH) were measured in the basal sample and at 30, 60 and 90 minutes. Standard radioimmunoassay procedures were used for all hormone assays. Coefficient of variation for the assays was between 3–5% for all hormone studies.

EEGs were taken in six subjects, using an identical recording protocol to that described in the previous study of electrical stimulation.[3] The EEG recordings were repeated one to three weeks after stimulation. The EEGs of four subjects who had also taken part in the earlier study were compared with their previous recordings.

A Digitimer D190 magnetic stimulator was used with a 6-turn coil, 10 cm in diameter, positioned with its centre over the vertex. The intensity of stimulation was adjusted until an obvious jerk of the arms was seen. The number of stimuli varied between 10 and 50 (most subjects receiving 30) with an interstimulus interval of around five seconds. No attenuation was made to determine precise thresholds for cortical excitation.

The responses of GH, PL and cortisol in relation to magnetic stimulation and the control period are shown in the figure. There were increments in GH in five out of 17 subjects following stimulation and in three out of 11 subjects during the control period. These subjects were all females aged between 26 and 58 years. In all except one, the GH concentration had begun to rise before the onset of magnetic stimulation. In this subject, GH started to rise 30 minutes after stimulation and reached a peak at 60 minutes. In two subjects who showed GH changes there were similar patterns of change in PL and cortisol. In all male subjects the GH levels remained $< 0{\cdot}5$ mU/l throughout the test and control periods.

Cortisol and PL responses in all subjects were very similar on both days. No significant changes in LH, FSH or TSH concentrations were seen in any subject.

All EEG records taken before stimulation were within normal limits. No change in EEG activities was seen immediately after stimulation or in recordings one to three weeks later. There were no differences between EEGs taken during the present and previous study[3] in the four subjects participating in both procedures.

Changes have been reported in several pituitary hormones in relation to electroconvulsive therapy and seizures.[4,5] It has been suggested that increments in PL, GH, TSH and gonadotrophins are specific, and PL in particular has been widely used in the differential diagnosis of seizures. In this study,

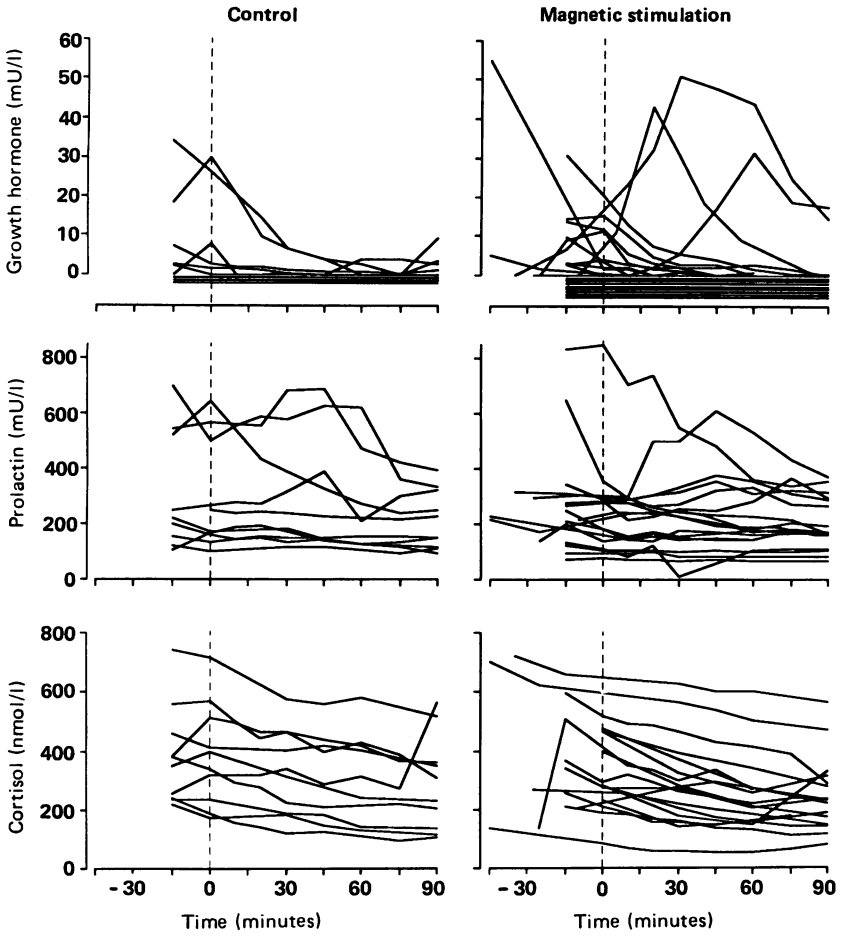

Figure Growth hormone, prolactin and cortical responses of individual subjects in relation to the magnetic stimulation and control periods.

however, no changes in gonadotrophins or TSH were seen in relation to magnetic stimulation. The changes in PL, GH and cortisol were most likely due to non-specific stress, as similar patterns were seen during test and control periods, and in most instances the rise in hormone concentrations began before stimulation. The concomitant increase in cortisol, PL and GH seen in two subjects is further evidence that the hormone changes are related to a stress response. Earlier studies have shown the effects of various forms of stress on hormone concentrations, with marked variation between individuals.[6] The increment in GH that occurred during the post-stimulus period was in a young female subject, and was most likely due to a spontaneous physiological pulse of GH (these occur more commonly in younger women).

The only previous published report showed a fall in PL with magnetic stimulation,[2] but we were unable to confirm this finding.

No changes in the EEG were seen in the half hour following stimulation, confirming previous reports.[2] It is interesting that no long term changes are seen in those subjects who had undergone electrical stimulation 18 months before, particularly since that technique produces higher current densities in the cortex than magnetic stimulation.

We conclude that there are no changes in plasma levels of pituitary hormones occurring as a direct or specific consequence of transcranial magnetic stimulation as used in clinical practice. The absence of EEG changes is also encouraging evidence of the safety of the technique.

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Association of amyotrophic lateral sclerosis, Hoigne's syndrome and residence in Guam

Anaphylaxis is a form of generalised trauma and trauma itself has long been suggested to have a role in precipitating amyotrophic lateral sclerosis (ALS). We report a case of ALS which appeared to be precipitated by an acute anaphylactic reaction to penicillin.

The patient was a 32 year old male right handed married black American. He worked as a welder in the American navy and in 1971 he was stationed on the island of Guam for one year. Six years later he received four intramuscular injections of penicillin for gonorrhoea. After the second injection he had a severe reaction with dizziness, chest pain, numbness in the left arm and leg, muscle spasms, nausea, throbbing pain in the neck radiating to the occipital region, diplopia, black and white flashes, hot flushes, buzzing in the ears, a choking sensation, intense anxiety and panic. These symptoms occurred almost every other day for several weeks and lasted 10–15 minutes each time. They were not related to exertion. There were no aggravating or relieving factors. Physical examination was entirely normal. Repeated electrocardiograms and electroencephalograms during these attacks and a brain computerised tomography (CT) scan were all normal. A diagnosis of conversional reaction and fatigue neurosis was made and treatment with diazepam, breathing into a paper bag and psychotherapy was started but without any effect.

Three months after his initial presentation the patient became anorexic and began to lose weight. He then became aware of difficulty in speaking and was conscious of very poor tongue movements. A few months later his legs and then his arms became progressively weak.

He had mumps and measles as a child and also mild concussion playing football in high school. At the age of 19 years he was involved in an automobile accident during which his head went through the windscreen. He had also been treated for venereal disease six or seven times. He did not smoke and drank alcohol occasionally. His only medication was diazepam 5 mgs twice daily. He was allergic to penicillin. His mother and brother were hypertensive, but there was no family history of neuro-psychiatric disorders.

On neurological examination three months after the initial presentation there was no intellectual impairment but he was moody at times and emotionally labile. The cranial nerves were intact except for a small spastic tongue and an exaggerated jaw jerk. Widespread fasciculations were present in all four limbs and there was severe wasting of the intrinsic muscles of the hands and moderate wasting around the shoulder girdle. Muscle tone was spastic in all limbs, the legs being affected more than the arms. There was mild proximal and moderate distal weakness in the upper limbs but there was no weakness in the legs. The tendon reflexes were brisk in all limbs and both plantar responses were extensor. There was a non-sustained clonus of the left ankle. He walked with a broad-based spastic gait. There were no abnormal sensory or cerebellar signs detected. His pulse was 110/minute and regular. Blood pressure was 110/70. The rest of the general physical examination was unremarkable.

Routine blood tests and plasma noradrenaline levels were normal. Serological tests for