

Thresholds for perceiving a metallic taste at large magnetic field

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INTRODUCTION

People moving in large, static, magnetic fields, report various sensory disturbances such as vertigo, magnetophosphenes and the sensation of a metallic taste in the mouth [4]. It is thought that these may be due to an interaction between the electric fields induced in the head when moving in a magnetic field, and the sensory systems. However the detailed mechanisms of these interactions are not understood. Furthermore, it is not known what fraction of people experience these effects, or what sorts of movement, magnetic field profiles and rates of change of magnetic flux (dB/dt) elicit the effects. The aim of the study described here was to determine a threshold dB/dt for the perception of a metallic taste for different types of head movement in a static field.

METHODS

Twenty subjects (11 male, 9 female, mean age 29 ± 6 y.) were recruited for the study which was approved by the Local Ethics Committee. Subjects were required to carry out two types of head motion whilst seated 80 cm from the bore of a 7 Tesla MRI scanner (mean head height = 1.2 m) in a field of approximately 0.5 T and a gradient of 1 T/m, and to report whenever they experienced a metallic taste in their mouth. This position was chosen as it allowed the subjects to sit down at the start of the experiment without experiencing any metallic taste. Subjects carried out either head (1) rotations in the horizontal plane or (2) nods in the vertical plane for a 20 second periods, repeated 5 times. Subjects were required to synchronize their head movements with the beat of a metronome at five different beat rates (40, 60, 80, 100 and 120 beats per minute where 2 beats are required for a cycle). Subjects were required to rotate their heads through 105° in the horizontal plane or 85° in the vertical plane. Subjects were asked to drink a cup of still bottled water prior to the test. They were asked to keep their mouths closed during the experiment, due to anecdotal evidence that this increased the perceived metallic taste. A purpose built dB/dt meter consisting of three orthogonal search coils (100 turns, $A=284.0\text{mm}^2$) was used to measure and record the induced *emf* as a result of head motion in the magnetic field. The coils were calibrated using a solenoid coil driven with a known dB/dt. The search coil assembly was lightly attached to the side of the head adjacent to the sphenoid bone. Mean peak dB/dt values were calculated at each beat rate, averaged both over all subjects and over all subjects for whom the particular beat value was the threshold of stimulation onset of metallic taste.

RESULTS:

Horizontal head rotation induced metallic taste sensation in 60% of subjects (table 1). The threshold at which the subjects experienced a metallic taste varied from 60 to 120 rotations per min. The magnitude of the corresponding mean peak induced dB/dt ranged from 1.2 T/s to 4.0 T/s. Only one subject reported metallic taste sensation during the head nodding task inducing a mean peak dB/dt of 1.4 T/s. Figure 1 shows typical dB/dt record at 80 b.p.m. during horizontal head rotation. Similar curves were obtained for head nodding, although the peak dB/dt were typically 50% lower for matched frequencies of motion.

DISCUSSION AND CONCLUSION:

This study has shown that the perception of a metallic taste depends on the rate of head motion, and also on the direction of head motion, although this may be because of the differences in induced dB/dt. Recording the exact threshold dB/dt for detection is difficult because of the problems of recording a subjective response, but this study indicates that 50% of subjects will perceive a metallic taste for a head rotation (perpendicular to the field) of 80 b.p.m. corresponding to a dB/dt of 2.3 ± 0.3 T/s for those subjects. It is interesting to note that the dB/dt was greater at a given beat frequency for the subjects for whom that frequency was the threshold, suggesting that variations in movements play a role in determining individual thresholds. The magnitude of the sensation of metallic taste increased with rate of head movement. Several subjects also reported a lingering metallic taste at the end of the task but this subsided within minutes of completion of the experiment. It appears that the geometry of the mouth and tongue may also be important with the main current path being across the tongue and back via the roof of the mouth. It is likely that electrolysis of the saliva (detected as acid taste) is the dominant mechanism. Future work will be aimed at more fully characterising the direction of field changes required to induce a metallic taste, and at determining the basic mechanism of this effect.

REFERENCES: [1] ICNIRP Statement, *Health Phys.*, 87,[2], 197-216, 2004. [2] National Radiological Protection Board (NRPB), *Br J. Radiol.*, 1982; 56:974-977 [3]International Electrotechnical Comm.(IEC). International standard: part 2. **CEI/IEC 601-2-33, 1995.** [4] Schenk, J.F., *J. Mag. Res. Img.*, 12, 2-19, 2000.

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Table dB/dt levels corresponding to threshold for detection				Figure 1: Induced dB/dt values from 3 orthogonal coils mounted to the head during 20 second horizontal head rotation task.	
Beat frequency (b.p.m)	Number of subjects for which this was threshold for detection	dB/dt Mean +/- SD T/s	dB/dt for the subjects for whom this is threshold of detection Mean +/- SD T/s		
60	3	1.8±0.2	1.9 +/- 0.8		
80	7	1.3±0.3	2.3 +/- 0.3		
100	1	2.9±0.3	3.8		
120	1	3.5±0.3	4.0		