

Audio-tactile multimodal perception of tissue-conducted sound fields

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Abstract:

Background

Approximately 5% of the World's population, that is, 360 million people, suffer from "disabling hearing loss" and the proportion of over-65s rises to about 33%. 13.4% of geriatric patients have significant conductive components to their hearing loss.

For this segment of the population, "music deprivation" may have significant long-term health and wellbeing consequences amounting to diminished quality of life (QoL).

Assistive technologies implementing sensory augmentation could ameliorate the effects of lack of ready access to music, the experiential attributes of music listening can be reinstated and tangible benefits might accrue.

Aims

Aim: to extend human perception through application of multimodal audio-plus-tactile stimuli

Objectives:

- Investigate how perception can integrate multimodal stimuli;
- Investigate how *novel* multimodal stimuli can engage perceptual learning.
- Investigate whether this approach offers enhanced communication, and enhanced quality-of-life (QoL) in cases of conductive hearing loss

Methods

A spatial array of vibro-mechanical transducers for bone-and-tissue conduction has been used to convey spatial ambisonic soundscape and spatial musical material. One hundred volunteers have undergone a five-minute listening experiences, subsequently describing the experience in their own words, on paper, in an unstructured elicitation exercise. The responses have been aggregated to identify descriptive themes, which were then mapped against each other to identify to what extent the experience was valuable, enjoyable and informative, and what qualia are may be available through this technique.

Results

Emergent key themes were: "positive" (77%), "spacious", "interesting", "weird", "clarity", "vibrations" and "feeling-descriptions" (such as "dreamlike").

The attribute class that mapped most strongly to 'positive' was 'interesting' (35%) followed by 'spatial' (32%), feeling-descriptions (26%), 'clarity' (19%), 'vibrations' (15%) and 'weird' (11%).

Conclusions.

The spatial qualia elicited are notable, since psychoacoustic theory does not predict that spatial impressions extend beyond a simple lateralisation paradigm. Without pinnae effects (or some signal-

processing equivalent), elevation and externalisation should not be discernible. It may be that listeners are utilising tactile cues in cognitive spatial mapping, which we shall investigate.

It appears that this experience differs qualitatively from other (air-conducted) forms of listening and that a majority found the experience positive, interesting and strange; many expressed interest in repeating the experience. It may be that the novelty of the experience was conflated with positive judgements.

We also observe that the vibro-tactile stimuli inherent in this technique seem to contribute to, rather than detract from, the experience, indicating that the multimodal stimuli are sometimes neuronally additive. Future work will focus on quantifying the features of this multimodal interaction.