Sonification: Principle, Methods and Medical Applications

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Abstract

Background and Aim: Sonification is defined as "the use of non-speech audio to convey information or perceptualize data". The basic principle in sonification is to establish a correspondence between input data and sonic output parameters – "parameter mapping". *Materials and Methods:* Several sonification techniques have been developed, including our 3-level approach: A-acoustic level – output pitch (frequency) is a continuous linear/exponential function of main input parameter (signal amplitude), S – sonic level – similar to A, but discrete function and temporal rescaling and M – musical level, where rhythm and harmony are added. As input date we have used either biosignals (ECG, heart rate from Physiobank and own records) or molecular sequences (protein primary structures). We tried also various tempolenses, to dilate or compress the signals. Only A and S level algorithms have been developed and used in MATLAB programs. *Results:* Several sonification techniques and tools have been developed yielding to a large variety of medical applications of sonification for either warning systems (alerts), for process monitoring (ICU, exercise etc.) or therapy/recovery. Our own results were posted on our library of sonic transforms of several biosignals (normal and pathological ECGs and HRs, mouse pulse wave and a couple of molecular (proteic) sequences, with or without motifs (www.medinfo.umft.ro/dim/sonification). Various patterns of parameter mappings have been tested, revealing an optimal setup for warnings in exercise test in clinical environment. A study on discriminant power was also performed, showing the relation between the capacity to memorize or recognize sonic fragments and complexity of parameter mapping. *Conclusions:* Sonification is new method for (medical) data representation, still insufficiently explored as a practical tool, with a high potential to be associated to novel holistic representation of complex human mental, emotional and health state.

Keywords: Sonification; Parameter Mapping; Tempolenses; Warnings; Biosignals; Molecular Sequences; Discriminant Power