

## **End of Award Summary Report**

**Agile Seed Funding Project:** "Listen to your heart": crowdsourcing of in-ear heartbeat sounds at the Montréal Science Center

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This project aims to automatically detect emotions based on biosignals recorded inside the ear, with the overarching objective of adapting an earpiece to remove distressing sounds for people with auditory sensitivities.

To this end, our original goal was to establish a database of emotion-correlated in-ear audio by extending the Montréal Science Center exhibit "Mes émotions à fleur de peau". We planned to invite hundreds of visitors to wear the auditory research platform (ARP) and record from the ARP's outer- and in-ear microphones while they were presented with affective stimuli that were already part of the exhibit. However, due to the COVID-19 pandemic, data collection at the Science Center was not possible.

Instead, we conducted a small pilot study at the NSERC-EERS Industrial Research Chair in In-Ear Technologies (CRITIAS). Danielle Benesch, the MS student working on this project, presented the preliminary data at the 2020 Acoustics Week in Canada and the 2021 National Hearing Conservation Association Annual Conference. We also preserved the interactive element that we had prepared for Science Center visitors—immediately upon completion of the study, participants were shown an audiovisual representation of their maximum and minimum heart rates, using the recording of their in-ear audio and the corresponding spectrogram.

While our current dataset contains much fewer participants than originally anticipated, collecting data at CRITIAS had several benefits: the recordings took place inside of an audiometric booth, participants were provided with the optimal ear tip size based on fit tests, and auditory stimuli were played directly into one earpiece of the ARP, yielding relatively controlled conditions to analyze the interference of these audio signals on the extraction of in-ear heartbeat sounds. Compared to what would have been feasible at the Science Center, we were able to record for a longer duration per participant, making the resulting heartbeat data suitable for standard heart rate variability analyses. Participants also rated the affective content of all of the stimuli, providing ground-truth emotion labels for each individual.

We used the Agile Seed Funding for equipment to measure heartbeat and respiratory signals for future data collection: we purchased the Zephyr BioHarness (~\$900) to record electrocardiography and respiratory signals from the chest, as well as an electrocardiography/photoplethysmography kit and accessories (~\$600) to record heartbeat signals from other parts of the body. This equipment will allow us to assess the accuracy of heart rate variability estimates based on in-ear audio, compared to the gold-standard based on electrocardiography.