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“listen To Your Heart”: Exploring The Link Between In-Ear Audio And Emotions
Danielle Benesch, Corentin Delain, Rachel Bouserhal, Stefanie Blain-Moraes, Jérémie Voix

Wearing passive hearing protection to manage auditory sensitivities can sometimes lead to the opposite end of the spectrum where the surrounding sounds are over-attenuated and wearers can no longer fully engage with their surroundings. A “smart” hearing protection device could satisfy both needs by attenuating distressing sounds while relaying useful sounds. And since each individual may be sensitive to a unique constellation of sounds, this device would ideally be customized to the needs of each wearer. A hearing protection device could conceivably adapt to the idiosyncratic sensitivities of individual wearers by monitoring their biosignals to detect sound-induced distress. When the earcanal is acoustically sealed by a hearing protector, biosignals can be captured due to bone-conduction sound amplification or the “occlusion effect”. The amplified biosignal sounds can be recorded with an in-ear microphone and classified automatically. Among the audio events that can be extracted from in-ear microphone data are heartbeat signals. Drawing upon previous psychophysiological research using heart rate and heart rate variability to study emotions, this project proposes inferring an individual’s affective state based on the heartbeat extracted from in-ear audio. To assess the suitability of the in-ear heartbeat as an indicator of affective state, stimuli intended to evoke certain emotions are played while audio is recorded inside the ear. Preliminary results are discussed, as well as the feasibility of a potential application: the automatic classification of distressing sounds by a hearing protection device.

In-Ear Speech Capture On Electronic Hearing Protectors: Optimization Of The Denoising Algorithm In Transparent Mode
Corentin Delain, Farid Moshgelani, Rachel E. Bouserhal, Jérémie Voix

Providing industrial workers with satisfactory hearing protection and communication in noisy environments is still a challenge and often requires a compromise of one or the other. An intra-aural hearing protection device (HPD) equipped with an in-ear microphone (IEM), miniature loudspeaker, and an outer ear microphone (OEM) has been recently developed for communication in noise. The voice of the wearer is captured from inside the occluded earcanal and the speech signal is further denoised from residual ambient noise and subsequently enhanced to increase its frequency bandwidth. Currently, when the ambient noise level is greater than 85 dBA, the denoising of the IEM signal is performed in a so-called “noise isolation mode”, where the HPD provides full passive attenuation of ambient noise. However, in moderate ambient noise levels, it is desirable to maintain the situational awareness of the wearer by allowing ambient sounds captured by the OEM to be played through the internal loudspeaker (electronic “talk through”). This mode of operation is herein referred to as “acoustical transparency mode” and creates added challenges, as the IEM picks up the voice of the wearer as well as the ambient noise played back by the loudspeaker inside the occluded earcanal. The present study details the denoising approach developed around the use of adaptive filters. The effects of loudspeaker gain, ambient noise level, and fit of the HPD on the transparency mode algorithm are investigated to optimize its performance and integration.

Hpd Fit-Testing Feature Developed Within A Hearing-Care Platform For Musicians
Lucas Einig, Romain Dumoulin, Isabelle Cossette, Jérémie Voix

The hearing-care platform is a dedicated software and hardware solution intended for university music students to assess an individual’s noise exposure and to promote hearing health. As the level of exposure is measured using a calibrated microphone set on a smartphone app, the attenuation provided by the -possible- use of a hearing protection device (HPD) needs to be taken into account in the calculation of the protected noise exposure. To quickly estimate the attenuation provided by a HPD, a new app functionality has been developed featuring a) an audio stimulus generator – that can produce loud tones through the smartphone embedded loudspeakers, b) a graphical user interface that can display a count of the audio stimuli perceived, and c) an attenuation prediction algorithm that can estimate the overall attenuation of the HPD under test. The proposed measurement approach relies on a threshold-based method where sequences of octave band-centered narrowband stimuli are played in
steps of 5 dB. The user simply counts the number of tonal bursts perceived before stimuli become inaudible in two conditions: when both ears are occluded with the HPD and when they are not occluded. From the two count values, the HPD octave-band attenuation is computed. Attenuation data can be assessed for different HPDs and applied to each activity exposure with an adjustable wearing time (from no HPD to HPD being worn during the entire activity). In addition to improving individualized assessment, this feature is also a great educational tool to demonstrate the benefits of HPDs.

Evaluating The Accuracy Of Lip Motion Tracking Using Surface Scanning Face Tracking Technology
Roujan Khaledan, Andrew (U San) Chao, Caroline Jeffery, Gabriela Constantinescu, Daniel Aalto
Speech-Language Pathologists diagnose Motor Speech Disorders (MSD) by visually inspecting differences in facial motion, specifically range of motion and trajectory of the lips. Visual inspections are subjective, making it difficult to precisely track movement. Digitally tracking facial motion has the potential to refine the diagnostic process, characterize MSD, and monitor treatment impact. In contrast to traditional motion tracking systems, which are only available in specialized centers, mobile devices and the integrated facial tracking systems are ubiquitous and offer an accessible alternative to traditional systems. The goal of the present work is to evaluate the accuracy of lip tracking based on mobile surface scanning technology. Using a custom app based on Apple’s augmented reality environment (ARKit), one of the authors recorded their facial movement for both natural speech and extreme non-speech gestures. This app tracks 1220 mesh points on the face while recording video (both at 60 frames per second). The TrueDepth iPhone camera was placed 55 cm from the speaker and positioned at their eye level. Accuracy was defined as the distance between a visible anatomical landmark on the lip (flesh point) and the corresponding tracked mesh point. For each gesture, the deviation of the flesh point from the mesh point was calculated from a single frame. Understanding the accuracy of the app for different tasks can have an impact on future clinical and research use, and it may motivate the development of an automated adjustment for the flesh point-mesh point deviation.

Direct Manipulation Of Variability In The Auditory Feedback System Via Real-Time Formant Perturbation
Daniel Nault
Auditory feedback is an essential part of speech motor control and speech learning. When feedback is perturbed in laboratory settings (e.g., Houde & Jourdan, 1998), speakers, on average, compensate for the perceived error. There is, however, considerable individual variability in the magnitude of speakers’ responses to feedback manipulation (e.g., Purcell & Munhall, 2006). Here, we address one potential source of this variability by manipulating the predictability of auditory feedback of 20 female speakers using a real-time formant perturbation system. Participants produced the English word “head” 80 times in 3 different conditions. During the Perturbation phase of each condition (i.e., trials 20-50), subjects were presented with random first and second formant perturbations that produced feedback varying between the vowels in “hid” and “had”. Predictability of the perturbations in the conditions varied, such that: (a) on each trial, a different perturbation was introduced, (b) perturbations were consistent for three trials, or (c) six trials. Time series analyses were performed to examine whether compensatory behavior differed among speakers in the three conditions of varying feedback predictability. Results will be discussed regarding the possible role of variability in speech motor control and the importance of developing methods to detect state-change in individual time-series data.

Transfer Of Training Across Speakers And Languages In Learning Time-Compressed Speech
Cynthia Sedlezky
A key criterion for successful learning is generalization beyond the training conditions. Here we examine the perceptual learning of time-compressed speech and study generalization to speech produced by different talkers in different languages. This research tests the importance of learning low-level acoustic properties of speech for transfer of training. Monolingual and bilingual adults were trained in English over 8 sessions using passages of progressively more time-compressed speech from a novel. The speech rate during training sessions corresponded to their threshold of intelligibility as assessed by scoring the SPIN sentences recorded at 14 rates (100-425%). To assess transfer of their ability, a similar task with English or French sentences produced in the same or a different