Intrinsic Integration and the Design of Games for Auditory Perceptual Learning

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Difficulties communicating are common in everyday life. It is frustrating when you cannot understand someone at the pub or on a bad mobile phone connection. The education of children is hampered when they cannot understand the teacher because the classroom is noisy. The frequency and severity of these communication difficulties are increased for individuals with hearing impairments. Auditory assistive devices (e.g. hearing aids or cochlear implants) reduce some of these difficulties. Unfortunately, it can take many months of continuous use before patients achieve the maximum benefits. During this initial familiarization stage, many users grow frustrated and discontinue using their assistive devices.

Technology-enhanced training may reduce the communication difficulties of the hearing impaired. *Auditory training* promotes *perceptual learning* (the modification of perception and behaviour following sensory experience) on both trained and untrained tasks (see, for example, Tallal, 2004; Moore et al., 2005; Sweetow & Palmer 2005). Existing training approaches have been derived from paradigms of auditory *testing* with conventional, multiple-alternative, forced-choice, sound-discrimination exercises (see Sweetow & Sabes 2007; Fu & Gavin 2007). Testing based approaches to training are not the most effective way to promote learning.

The efficacy of training often depends on the degree to which the training paradigm is interactive, immersive, and engaging. For these reasons, interactive game technologies are increasingly being considered as an attractive means to deliver such training. Although some auditory training paradigms provide *extrinsic motivation* (e.g. rewards, engaging user interface), they rarely promote *intrinsic motivation* (e.g. fantasy, control and challenge; see Malone 1981). Research into the design of computer-based learning systems has identified methods of effective training that could be applied to auditory perceptual learning. Similarly, research into design of computer games has also identified methods of enabling engagement, through a combination of intrinsic and extrinsic motivation. The combination of both approaches has already produced insights on how to design effective educational games. At its core is a concern for a proper integration of the learning material with the fantasy construct of the game and its mechanics (i.e. *intrinsic integration,* Malone & Lepper 1987; Habgood 2007; Kenny & Gunter 2007): the more intrinsically the coupling, the more effective the learning.

Our aim is to investigate how auditory perceptual learning, educational technologies and game design can be further combined into an approach of training that is suitable for use by individuals *outside the laboratory*, e.g. on home computers or mobile devices. Projects are underway to develop *casual games* for training on basic auditory tasks (e.g. discriminating between two frequencies or identifying the location of a sound source) and on more "realistic" listening tasks and social settings (e.g. speech intelligibility in "cocktail party"

settings). The design methodology will be based on user-centric approaches, including participatory design, rapid and incremental prototyping, usability studies and formative evaluation. The efficacy of the design approach will be compared both from an auditory learning point of view (e.g. changes in performance) and from a user engagement point of view (e.g. flow experience).

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