Automatic Face Recognition

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Automatic face recognition: A new method for the behavioural assessment of hearing in young infants?

Jackson, I. R.¹, Hunter, L. L.²,³, Moore, D. R.¹,²,³, & Munro, K. J. ¹,⁴

¹Manchester Centre for Audiology and Deafness, School of Health Science, University of Manchester, UK
²Cincinnati Children's Hospital, USA
³University of Cincinnati, USA
⁴Manchester University NHS Foundation Trust, UK

Introduction

- The ability to detect and discriminate between sounds is crucial for infants’ language development.
- Early intervention leads to improved language outcomes for those infants who require management for hearing impairment (Ching et al. 2017).
- Behavioural responses to sound are considered the “gold standard” measure of assessment as they provide insight on the functioning of the entire auditory system (unlike objective physiologic tests, such as otoacoustic emissions, OAE, and auditory brainstem responses, ABR).
- However, obtaining reliable and resource-efficient results in young infants is a significant challenge.
- Here we present a novel approach for the behavioural assessment of young infants – automated detection and analysis of facial features (Jackson et al. 2018)
- Patent Pending (Application Ref. GB 1817803.8)

Challenges in behavioural testing of young infants

- Young infants’ behavioural responses are limited to supra-threshold sound levels.
- Behavioural responses can be subtle and highly variable (both within and between individuals).
- Tests require expert examiners, which makes them expensive, and limits the ability to provide widespread screening.
- Current procedures are slow to deliver and score, and infants habituate rapidly to sounds presented to them, meaning that many become too fatigued to complete the test.

The general consensus in clinical practice is that behavioural observations cannot be relied upon until infants reach a developmental age of around 7–9 months (when head turns to sound can be elicited and rewarded; Widen, 1993). Even then, test procedures can be time- and labour-intensive, and scoring is subject to bias.

A method which offers reliable information about behavioural responses of infants younger than 9 months would be highly valuable. Other populations who cannot provide reliable responses could also benefit from such a method.

Applying new technologies to infant audiology

Detecting facial features

Advances in technology open the door to novel approaches in the assessment of behaviour. One approach we are exploring is to combine automatic detection of infants’ facial features with machine-learning algorithms to detect when an infant responds to a sound.

In this approach, software such as OpenFace (Baltrušaitis et al. 2018) is used to automatically detect the features and orientation of infants’ faces, as shown in Figure 1.

Once a face is detected, we can monitor its orientation and features to track if and how they change over time, as shown in Figure 2. Tracking faces over time allows us to measure any changes following the presentation of (or a change in) a stimulus. If infants show a response when they hear a sound, such as raising their brows or widening their eyes, for example, they provide a measurable pattern of behaviour we can capitalise on.

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Figure 1. Example of the automatic detection of facial features. Here, open-source software captures both the overall head position (blue box) and facial features (red dots) in a video of an infant.

Figure 2. Continuous tracking of different features and orientation of an individual infant’s face.

Training machines to learn patterns

Differences in patterns of response behaviours might appear subtle - or even invisible - to the human eye, but can be easily detected by computers.

We will train algorithms to recognise patterns of behaviour infants show following the presentation of a stimulus. We will also train them to recognise the normal, spontaneous patterns of behaviours we see when no stimulus is presented.

Once trained, we can then use the learned patterns of behaviour to detect whether or not other infants appear to respond to different stimuli (see Figure 3).

Summary

- The benefits of newborn screening and early identification of hearing impairment are currently not fully realised due to the limitations of behavioural techniques.
- New technology can offer novel insights into infants’ behavioural responses, including those beyond the natural limitations of human observers.
- Our ongoing work attempts to combine novel response measures and machine learning in order to determine when an infant hears a sound.
- Approaches like ours, aided by advances in technology, have the potential to revolutionise infant hearing assessment in research labs and clinical practice by offering accessible, fast, inexpensive, and easy to use tools.

References


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