Developing OperaVOX – the On PErson Rapid vOice eXaminer app

Harnessing the power of the iPhone, iPad and iPod Touch to make advanced voice analysis easy and possible almost anywhere

Dr Owain Rhys Hughes,
ENT Registrar at the Royal National Throat Nose and Ear Hospital, London, UK.

Dr Anil Alexander,
Chief Scientific Officer for OperaVOX, UK.

Correspondence
E: owainrhyshughes@gmail.com

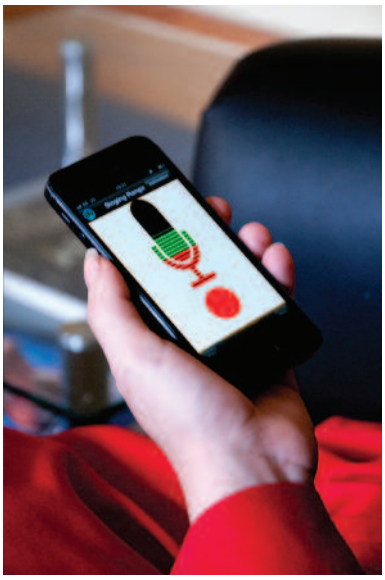
Declaration of Competing Interests
None declared.

The OperaVOX concept

OperaVOX was conceived during the second year of my PhD; at the time I was trying to find an easy way to collect a large amount of data on the voice quality of patients with recurrent respiratory papillomatosis. The idea I had was that subtle changes to certain acoustic voice quality parameters may be a good indicator for when to perform surgery to remove papilloma from the vocal cords. I was very attracted by the idea that, instead of bringing patients into the hospital, these patients could be empowered to collect their own voice outcome data using a smartphone or a similar device. This would make data collection for research and clinical practice much easier. The ultimate aim was to develop an App to collect and monitor a whole suite of data on changes in each patient's voice and speech quality over time – the Voice Handicap Index (VHI), perceptual and acoustic analysis.

I was aware of a research study completed by a team at the University of Canterbury, New Zealand, in which either an iPhone or a professional headset microphone was used to collect voice and speech recordings for the purpose of acoustic analysis. By comparing the results from the two devices, this study demonstrated that the iPhone microphones are of sufficient quality to reliably perform acoustic measures of speech and voice quality [1]. The results of this study made it clear that it would be possible, at least in theory, to develop an Application that could deliver advanced voice quality analysis – importantly, without the need for any additional hardware.

On good advice, I began working with Dr Anil Alexander and Oscar Forth from a company based in Oxford called Oxford Wave Research. Dr Alexander has a PhD in acoustic voice analysis and Oscar Forth is an exceptional computer programmer. Together Anil and Oscar already formed an impressive team having already delivered acoustic analyses products to UK and foreign law enforcement, military and many other highly credible organisations – working in partnership with them has been an exceptionally formative experience.



OperaVOX runs on the iPhone, iPad and iPod Touch; these have microphones that are of sufficient quality for reliable acoustic voice quality analysis.

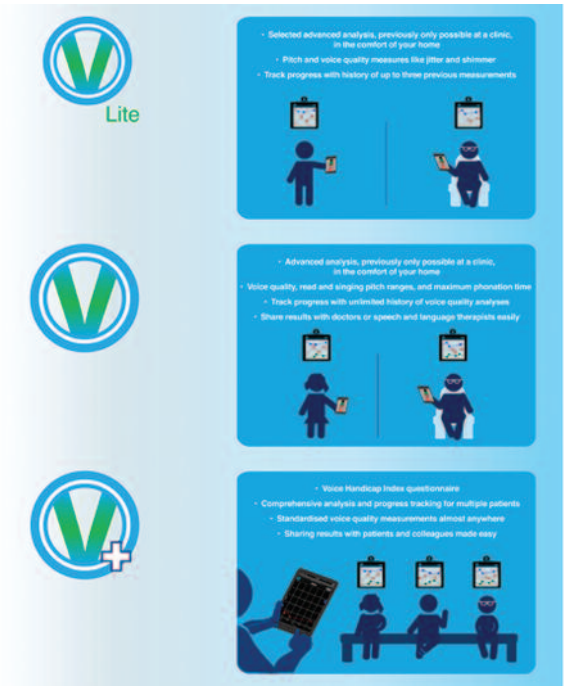
Over several meetings, myself, Anil and Oscar discussed what OperaVOX should deliver. The key features we decided on were (i) an easy to use user interface that a patient could use to reliably collect voice and speech recordings; (ii) a method to standardise the recording environment so that results are comparable wherever OperaVOX is used; (iii) on-device acoustic analysis in order to provide immediate feedback to the patient; (iv) ability to compare results over time graphically; (v) capability to easily build reports and share these via email.

I was very attracted by the idea that, instead of bringing patients into the hospital, these patients could be empowered to collect their own voice outcome data using a smartphone or a similar device

Refining and validating OperaVOX

One of the key concepts in innovation, particularly when developing new technology, is to gain feedback early and often from end users, iterate and gain more feedback. To this end, we spent a lot of time directly observing patients using OperaVOX and progressively refining the user interface based on their feedback. We built in an ambient noise monitor which samples the environment immediately prior to recording and informs the user if it is too loud for reliable analysis. We also provided the user with a visual loudness monitor which ensures that the user is phonating within a specific loudness 'window' – this feature removes the need for keeping the mouth at a fixed distance from the microphone (although this can still be used via a lanyard of fixed length if desired). Furthermore, we included both audio and visual feedback, in the form of a spectrogram, to the user after they had completed a voice recording.

Throughout the innovation process we were focused on developing a product that would be useful clinically. For this reason, we had to ensure the results that OperaVOX delivers were accurate when compared to the currently available technology. In the field of acoustic voice analysis the gold standard software is PRAAT; first developed some 20 years ago by Paul Boresma and David Weenink from the University of Amsterdam, PRAAT runs on a desktop computer and is free to download. We developed a three stage validation process for OperaVOX; first, 'in house' validation where we designed algorithms for acoustic voice analyses using the iPhone, iPad and iPod Touch based on formula in the published literature, secondly we tested and refined these algorithms until we obtained consistent agreement with results obtained on the same recordings using PRAAT, and thirdly we sought independent validation by Prof Birchall's research team at University College London. The independent validation was lead by Dr Marina Mat-Baki, a PhD student and ENT surgeon based at the Royal National Throat Nose and Ear Hospital. Dr Mat-Baki's work focuses on comparing the results obtained using OperaVOX to those obtained on the same recordings using both PRAAT and the commercially available Multi-Dimensional Voice Programme (MDVP) by Kay Pentax. The result of their comparison of OperaVOX to MDVP for both healthy volunteers and dysphonic patients was recently presented to the Laryngology 2013 Conference in London [2]; analyses of voice recordings from 16 healthy volunteers and 34 dysphonic patients demonstrated that there is very good agreement between MDVP and OperaVOX for F0, Jitter and Shimmer. Furthermore, test re-test agreement was moderate to excellent for all acoustic parameters.



There are now three versions of OperaVOX available to download from the Apple App Store: OperaVOX Lite which is a free trial version (provides F0, jitter and shimmer), OperaVOX which is designed for an individual user (has many more analyses including reading pitch range and email capability), and OperaVOX Multi which is designed specifically for clinical teams.

Bringing OperaVOX to market

We have developed OperaVOX to run on the Apple iPhone, iPad and iPod Touch because these devices have microphones of sufficient quality and uniform build for delivering acoustic voice analyses. Although an Android version of OperaVOX could run on more devices, at this time we cannot guarantee that the hardware of each of these devices are good enough for our analyses. We have now released three versions of OperaVOX onto the Apple App Store: (i) OperaVOX Multi, which is designed for clinicians and allows multiple patient profiles to be created and stored; (ii) OperaVOX (personal) which allows an individual to monitor changes in their voice quality over time and share results with others; and (iii) OperaVOX Lite which is free to download and delivers analysis of F0, Jitter and Shimmer. OperaVOX is now being used by a large number of speech and language therapists and ENT surgeons across Europe and as far afield as Australia, the USA, Canada, New Zealand and Brazil.

References

1. Lin E, Hornibrook J, Ormond T. Evaluating iPhone recordings for acoustic voice assessment. *Folia Phoniatr Logop* 2012;**64(3)**:122-30.
2. Mat-Baki M, Wood G, Alston M, Ratcliffe P, Sandhu G, Rubin JP, Birchall MA. *Reliability of OperaVOX™ as acoustic voice analysis software: preliminary results.* Presented at Laryngology 2013, London, UK, June 2013.