

# LEVERAGING PHONETIC AND SPEECH RESEARCH FOR IRISH LANGUAGE REVITALISATION AND MAINTENANCE

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## ABSTRACT

The ABAIR initiative illustrates how phonetic research can drive innovative applications that provide endangered-language communities with powerful tools and resources for language maintenance and revitalisation. ABAIR encompasses a cluster of Irish-language projects with parallel basic and applied research strands. These reflect its evolution from (i) developing phonetic/speech resources to (ii) building technologies (to date, TTS) that use these resources, and to (iii) implementing applications that exploit both resources and technologies to meet urgent needs of the language communities. A key feature is the ongoing collaboration with the language communities. Rather than passive recipients of resources (developed for commercial purposes), they actively help in setting research priorities, assisting the design, testing and dissemination of outputs, and increasingly, in the collection/curation of data. The paper describes two specific areas, education and access – both pillars of language maintenance – where phonetic resources and applications are impacting.

**Keywords:** Irish, phonetic resources, speech technology, access, education

## 1. INTRODUCTION

The unprecedented rate with which languages are being lost mirrors other catastrophic ecological losses of our era. Our languages are our greatest cultural artefact. They are also the receptacle of so much of our cultural inheritance: our songs, poetry, stories, literature, oral and/or written, the accumulation of wisdom and creative vision of preceding generations, which are lost with the language.

Phoneticians, through their documentation of the sound systems of the world's languages, through the provision of writing systems where such didn't exist etc., contribute in a variety of ways to the validation and maintenance of endangered languages. Typically, however, the language community tends to be the passive partner in this endeavour, and much of the

research output is consigned to academic publication.

The ABAIR initiative illustrates ways in which laboratory-based phonetic and speech research can be leveraged for language maintenance. A key element is that the research is carried out in such a way that the outputs are usable for speech technology development. This entails focussing at times on developing resources that are not typically on the phonetics menu. The ABAIR cluster of projects evolved in stages, from (i) laboratory-based development of resources for the dialects of Irish to (ii) exploitation of these resources in an Irish-language synthesiser. This led to (iii) a flowering of projects that deploy the resources, knowledge and technology for applications that target specific needs of the language communities. These three strands continue in parallel, providing a fusion of basic and applied research that is yielding very different kinds of research outputs.

The scope and aims of ABAIR developed organically – prompted in large part by the increasing involvement of, and sometimes, the urgent demands of the Irish-speaking community. Community involvement strengthens the research, bringing it out from academia to a place where it is used in ways that contribute to language revitalisation and maintenance. While every endangered language has its unique context, the challenges faced are common. In sharing experience, expertise and tools the hope is that these can benefit other communities whose languages are facing extinction.

## 2. CHALLENGES FOR LANGUAGE COMMUNITIES

Irish, a Celtic language, deemed 'definitely endangered' in UNESCO's atlas [1], is spoken in the Gaeltacht – small, Irish-speaking communities located mostly in the West of Ireland. The Gaeltacht communities are losing ground: it is estimated that even here, less than 25% of the population uses Irish on a day-to-day basis, and virtually all of these are bilingual. For an endangered language, Irish is rather unusual in being recognised as a national language, (since 2007, an official language of the EU), and it is

a compulsory school subject in Ireland. While this official status is important, the optics can be misleading: there are increasingly stark indicators of the decline of Irish in the Gaeltacht, and its transmission and future viability as a community language is in doubt. Many consider its survival to depend crucially on effective teaching, but sadly, the outcomes of Irish language education are often poor.

Among many factors contributing to the decline, two are often cited. The overwhelming influence of modern communication and speech technology, dominated by English, is seen by many as a major influence - particularly in the linguistic shift of young Gaeltacht speakers - by excluding Irish from what is now a central dimension of modern living. The other factor, Irish language education, is seen as falling short, both for Gaeltacht native-speakers and second-language learners. Complaints focus on dated methods and lacklustre materials which compare badly with those for other languages.

Linguistic factors present specific educational challenges. As in many minority languages, there is no spoken standard, but rather the three main dialects of Donegal, Connemara and Kerry, with further sub-dialects. These differ considerably in pronunciation, lexicon, prosody etc. (A written standard, which draws on different dialects [2] does not represent the speech of any given language community.) For native-speakers, there are few dialect-appropriate educational materials.

For non-native learners outside the Gaeltacht pronunciation is particularly problematic. The sound system of Irish contrasts palatalised and velarised consonants [3] - a fact generally not appreciated by learners or, often, their teachers. The mapping of sound-to-orthography is complex: as the Roman alphabet does not provide for the consonantal distinction, complex sequences of vowels are used, some of which indicate the quality of the adjacent consonant, some of which signal the quality of the nuclear target. The widespread lack of understanding of the basic sound system inevitably impacts also on literacy acquisition, as neither teachers nor learners tend to link the spelling rules of Irish to the underlying consonantal contrast, and learners must master the complex spelling without grasping its phonic basis. The fact that these same learners are English speaking and being trained on the "English" alphabet and phonics amplifies the problem. Where learners experience difficulties with Irish literacy acquisition, the only assessment and remediation tools are based on English - entirely unsuited to Irish. Non-native learners typically lack access to native-speaker models of the language. Homework can be problematic if learners and their parents don't know how text is pronounced. In the following sections we

outline the three strands of ABAIR's research, illustrating how they individually and cumulatively help to alleviate some of these difficulties and contribute to language revitalisation.

### 3. PHONETIC AND SPEECH RESOURCES

The initial aim was to develop phonetic and speech resources for Irish, in such a way as to provide the components necessary to text-to-speech (TTS) synthesis. Given the lack of a single spoken standard, a multi-dialect effort was deemed essential. Initial efforts focussed on the northern dialect of Donegal, and to facilitate extension to further dialects, a modular approach was adopted, where common and dialect specific components were identified.

**Corpora:** extensive recordings of a single speaker, using authentic dialect materials were needed to provide coverage of all sounds in all phonetic contexts. More compact *Corpas Beag* corpora that meet the requirement of coverage are now being perfected for the individual dialects. Beyond their use in TTS, these phonetically annotated corpora are providing rich databases for cross-dialect research.

**Letter-to-sound rules:** hand written letter-to-sound rules were developed for Donegal Irish and later adapted for other dialects. These rules are being exploited in educational applications (see below).

**Pronunciation lexica:** these provide for forms not predictable from the letter-to-sound rules. These are essential (with the letter-to-sound rules) for developing dialect specific applications.

**Intonation modelling:** there were virtually no available descriptions of Irish prosody. This necessitated considerable research, and large divergences among the dialects emerged [4-7]. It is planned to exploit these models in educational applications.

### 4. FROM RESOURCES TO TECHNOLOGY

These components allowed the building of the first text-to-speech system. A beta version, put on a website ([www.abair.ie](http://www.abair.ie)) for testing among colleagues attracted an unexpected flurry of emails from around the globe. These expressed relief at finally having a resource that allowed access to how Irish (text) should be pronounced. This was an intimation of things to come: from here the language community has led the way in demonstrating how such resources may help them and what they most urgently needed. It also revealed an unexpected online

global community, in itself a source of support for the language.

Synthetic voices – using both unit selection and HTS methodologies – are now available at [www.abair.ie](http://www.abair.ie) for the three main dialects of Donegal, Connemara and Kerry. A current goal is to extend the synthesis to the more endangered dialects. A synthesiser is a virtual native-speaker: having one not only serves to ‘preserve’ the dialect, but support the local community in their efforts to maintain it.

## 5. COMMUNITY DIRECTED APPLICATIONS

The online provision of the synthetic voices was a catalyst for collaborative projects to develop specific applications, responding to community requests.

### 5.1. Access

The ABAIR webpage [8] was used as a vehicle to give the public access to other resources, such as the *phonetiser*, which outputs the phonetic transcription of input text. The resources and applications currently under development will also be shared in this way. Public use of the synthesis facility is facilitated by a downloadable application which enables any online text to be read out. This provides native-speech output (with appropriate dialect) when reading dictionary entries, webpages, emails, etc. A mobile phone app version also provides speech output (to date available for a single dialect).

Long before the first synthetic voice was built, a short news piece about this research brought urgent appeals from parents of visually impaired children. Without synthesis, the education of Gaeltacht children is compromised, and outside the Gaeltacht, visually impaired children were largely excluded from Irish language education. Provision of a screen-reader thus became a priority. Collaboration with the National Council for the Blind of Ireland, enabled a blind researcher to work with us to implement Irish synthesis in the open-source NVDA screen reader [8]. This application can now be downloaded from the [abair.ie](http://abair.ie) site. It provides a choice of dialects and simultaneous Braille output. The user chooses the dialect and controls the speed (very high speeds are needed for browsing). The system was tested extensively in collaboration with teachers of the visually impaired nationwide [9].

A further collaboration, with ChildVision Ireland, entailed the production of DaisyBooks – speech-synthesis-enabled multimedia school books for the visually impaired. These allow magnification and highlighting of the text as it is read out, and user control over dialect and speed of output. In this work, volunteer assistance contributed greatly.

### 5.2. Education

Educational applications are being developed – and this is an area where all strands of our research come together. Phonetic knowledge and resources are being presented, using technology as the vehicle – as illustrated here by some ongoing developments.

**Pronunciation and phonological awareness:** A multimodal interactive game is being developed to train pre-literacy phonological awareness and pronunciation skills [10]. Learners train in the sound contrasts of the language through minimal pairs embedded in a game that can be played in the classroom or at home. The heroine of the game has the task of rescuing her brother from the fairy fort (a common folk theme). Numerous obstacles are encountered, but a friendly druid provides magic words and spells (minimal pairs and phrases featuring them). By correctly identifying and pronouncing these object-pairs, particular obstacles are overcome, allowing the heroine to proceed to the next level (the next obstacle). In its current form, the game is intended for classroom use, but the plan is to provide a phone/tablet version also for home use. A simpler phone app game is also under development, with less elaborate storylines and graphics, and featuring songs to consolidate the sound contrasts. These will be trialled in schools this autumn.

**From Pronunciation to Literacy Acquisition:** As mentioned above, most learners and teachers are not aware of the phonic basis for the orthographic rules of Irish, and the seemingly impenetrable nature of Irish spelling is seen as a major difficulty. As a follow-up on the phonological awareness game, an Irish alphabet game is being planned, where attention is subliminally drawn to the palatalisation-velarisation contrast and spelling rules. The colour and shape of consonant and vowel letters as well as musical cues identify the link of say, palatalised consonants and ‘permitted’ accompanying vowels.

**Speech based Writing/Reading Application:** *An Scéalaí* (The Storyteller) is an application currently being developed that will enable the spoken language to remain central to the development of ancillary language skills of reading and writing, spelling [11, 12]. This specifically targets the problem mentioned earlier that non-native learners have little exposure to native speaker models. One problem arising from this and the rather opaque writing system of Irish is that learners (or often parents, helping with homework) do not know how text should be pronounced. An *Scéalaí* is a web-based application which invites the learner to write text which is then

spoken by one of the ABAIR voices (with the choice of dialect up to the learner/teacher). Learners are initially invited to listen out for errors – as these are often more readily ‘spotted’ by ear – and correct their own text. In a subsequent step, the application prompts specific corrections (e.g., by colouring letters where a spelling ‘rule’ has been missed, such as the one corresponding to the palatalisation-velarisation contrast). The specific errors being focussed on at present are ones that pertain to phonological and morphophonemic alterations in the language. However, this application can be incremented by the teacher, and it can be used in the classroom and outside to target any aspect of the language. This application is being tested currently in second level schools in Ireland, as well as by learners abroad.

**A Chatting Companion (Chatbot):** An application we have been working on and which proved particularly popular when trialled among school children, presents a talking monkey who asks questions on specific topics [13]. The monkey speaks with one of the synthetic ABAIR voices. The learner responds in text (we have no recognition for Irish yet) and the answer is output in a different synthetic voice. The monkey uses very simple level of artificial intelligence and his conversation extends to a very limited number of topics (which feature in school oral examinations). However, it generates a remarkable level of interest and activity among the children among whom it has been tested to date, highlighting the power of communicative, task-based learning.

Interactive agents of this kind have enormous potential for language learning as they motivate the learner while exposing him/her to the spoken language, within a simulated communicative environment. We propose to extend the use of chatbots of this type, making them available for teaching. Even the most tedious language learning tasks (e.g., memorisation of irregular spellings, or complex grammatical rules) can be turned into a fun activity where the pupil competes with the monkey. Most importantly, through the use of the synthesis, the spoken language is centre stage.

## 6. CONCLUSIONS

Making resources available on or downloadable from the abair.ie webpage has been the primary means of dissemination to date. The synthetic voices on the site have been accessed 155,305 times in the first three months of 2019. In evaluations of the intelligibility of the synthetic voices (carried out in the context of the Chatbot application), 73% of 288 students rated them at points 4 or 5 on a Likert scale

– agree/agree strongly – for “the synthesised voices were sufficiently clear to make the speech intelligible”. Similar results were found for naturalness ratings [14]. These voices are increasingly also being sought for deployment in educational applications, such as *Duolingo*.

This ABAIR webpage also provides specific resources, as well as information on ongoing work, and explanations on how, for example, synthesis works. In the future, this page will include academic articles, and other research outputs. Education-oriented application, once sufficiently tested and robust, will be hosted on a linked educational webpage CabairE. The goal is to also to supply the tools that will allow teachers and other interested parties to develop materials, content and applications that can in turn be hosted on that site. Such a partnership will leverage the talent and experience of teachers and others interested in the teaching of the language, generating over time a virtual language-learning resource centre.

The partnership with the Irish speaking community has evolved, and specific interventions from groups and individuals continue to shape the direction of research. Collaboration is essential in all aspects of the work, including the design, testing and dissemination of applications. Looking to the future, a yet greater level of partnership is envisaged. For example, we are embarking on recognition and dialogue systems, which will require very large quantities of data to be collected and curated. We hope that our direct links with the community, along with online data collection methods (currently being perfected) will facilitate this endeavour. Ultimately, we would also hope to see joint educational programmes, in partnership with community-based organisations in the Gaeltacht, so that the researchers of tomorrow are drawn from and contributing to that pool.

A guiding principle in the present work is that the research outputs and applications be made freely available to the language communities who can benefit from them. As a corollary, the hope is to share expertise, experience and resources with other endangered-language communities, assisting them in their struggle to maintain their linguistic heritage.

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