

Geabaire, the First Irish AAC System: Voice as a Vehicle for Change

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Abstract

This paper introduces *Geabaire*, an Irish language Alternative and Augmentative Communication (AAC) system which is currently under development in the Phonetics and Speech Laboratory, Trinity College Dublin. This high-tech AAC system provides a vehicle for users who are non-speaking or minimally-speaking to converse with the world. *Geabaire* is one step in the movement towards the provision of access to the same technologies in Irish as in English, with the overarching goal of improving support for children who are neurodivergent or who have special educational needs who wish to speak Irish in a social or educational context. The development involves a community-driven, multidisciplinary team and involves co-design with autistic people, parents, teachers and speech and language therapists. This paper describes three initial approaches made – (i) the adaptation of an existing English system, (ii) efforts towards commercial collaboration and (iii) building a prototype within an existing open-source system – each of which provided lessons for future development. Based on these lessons, we embarked on building our own custom-made, native system called *Geabaire*. The challenges of development in a minority language – even a well-resourced one – are discussed and plans for future development are described.

Index Terms: AAC, Irish, speech synthesis, TTS, minority language, endangered language.

1. Introduction and Background

This paper introduces *Geabaire* (meaning ‘chatterbox’ in Irish) – an Irish language Alternative and Augmentative Communication (AAC) System which is co-developed with a community of users. Within an AAC system, the user communicates by selecting a series of images/words from a *board* (displayed on a tablet screen as in *Figure 1*), which are then concatenated and displayed as a sentence string at the top of the board, then spoken out by the synthetic voice.

AAC systems provide a vehicle for non-speaking or minimally-speaking people, and people with communication disabilities, to converse with the world. There are as yet no AAC systems available for Irish, which limits the ability of non-speaking and minimally-speaking people to access their curriculum in school and converse with friends and family. In Ireland, the

Education for Persons with Special Needs Act (EPSN) Act [1] commits to the provision of equivalent educational opportunities to children who have special educational needs and those without. In this light, it is disheartening to see many children’s access to Irish language education – and the cultural education associated with it - being withheld from students through automatic exemptions from Irish for all children who attend special schools or special classes in English-medium educational settings [2]. Despite this, there are many neurodivergent children and children with special educational needs who attend Irish-medium immersion education [3], and it is key to educational and linguistic equity that they have access to the same resources as their peers in English-medium education.

Our title – voice as a vehicle for change – is intended to reflect two intersecting assertions. The first is that, though people often equate speaking with thinking, voice is merely a *vehicle* for our thoughts and reflects them with varying degrees of accuracy. The second is that tools such as *Geabaire* – co-designed with a community of users – can bring about *change in the educational and social fabric of society* by allowing a more diverse range of people to engage with the language in social and educational contexts. This is not only of use to the individual AAC users who can now take a more active role in their communities; all of society benefit from this broader range of perspectives.

There are a number of existing English language AAC systems, and these provided the starting point for *Geabaire*’s development. On the face of it, the task of adapting an English system for Irish could seem like a relatively simple process, involving (i) translation of the source language icons/words into the target language equivalents and (ii) interfacing to a Text-to-Speech (TTS) system in the target language. Of course, the process is greatly more complex, one of the main challenges (provided one has access to an appropriate TTS system in the target language) arising from the need for the AAC system to properly capture the structure of the target language, which as in the case of Irish, may differ greatly from the source language structure. The task is an inherently interdisciplinary one, where linguistic knowledge, speech and language resources and technical development need to go hand in hand.

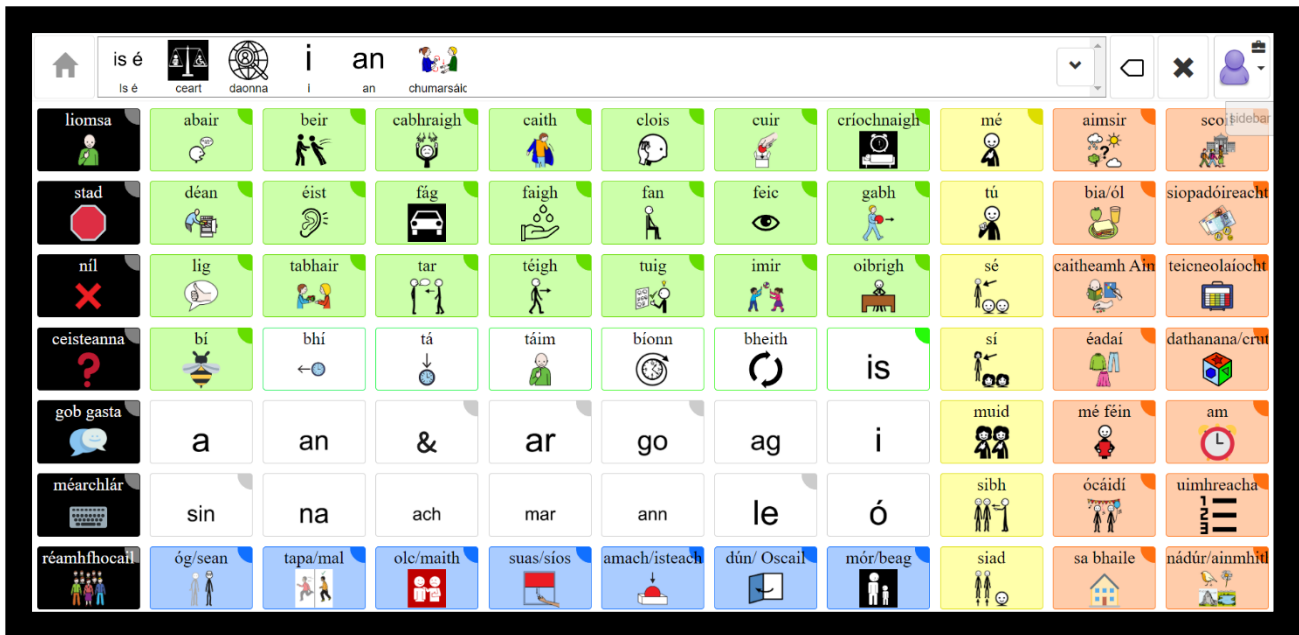


Figure 1 *Geabaire* Homepage

Geabaire utilised the TTS voices and builds on ongoing research of the ABAIR initiative (www.abair.ie) at the Phonetics and Speech Laboratory in Trinity College Dublin. Synthetic voices have been developed for the main dialects of Irish, and are already being deployed in educational [4, 5] and accessibility applications [6]. The compelling need for Irish AAC is illustrated in a parallel submission [7]. Note that technology provision for people who are neurodiverse or who have disabilities is an important dimension of the recently-published Digital Plan for the Irish Language [8]. In this paper we discuss the initial approaches taken to development – including the adaptation of an English system, an attempt at commercial collaboration and the building of a prototype within an open-source system. We subsequently discuss the current development of a custom-built, native system, *Geabaire*. Thus far, there have been many challenges to development - some of which are described here - and we anticipate several more before we have a final first version of *Geabaire*.

2. Initial Approaches

This section describes a number of initial attempts at adaptation or development. Providing a workable – if imperfect - system quickly was an initial practical goal, as we had embarked on this project with the educational and social needs of two children who needed Irish to access their curriculum and converse with family and friends at the forefront of our minds.

The needs-must attempt as described in [7] involved glossing Irish words to the nearest-sounding English words (e.g. <tee-shock> for *taoiseach* ‘prime minister’) and used English TTS. This attempt turned out to be unacceptable to users and teachers – not only as an insult to the ear – but also undermining the teaching of Irish pronunciation generally in the class. Note that the parent who made this initial attempt is now central to the development of *Geabaire*.

The commercial collaboration approach: the second attempt involved an approach to a widely-used commercial system, in the hope that ABAIR could provide the linguistic expertise and TTS to adapt their English system to Irish. This also proved unworkable: discussion revealed that the development would be more time-consuming and linguistically-complex than the company anticipated (seen as involving the two steps mentioned above (i) translation and (ii) interfacing to Irish TTS). There was no mechanism for us to access the language generation component(s) of the system – and as will be seen below, this is a *sine qua non*. An additional issue is that there would be no way to access user data, essential for the necessary research to develop it further. Furthermore, the limited numbers of potential users was clearly a major disincentive for a commercial enterprise.

Building a prototype within the open-source *CoughDrop* [6] facility, was decided on as a way of overcoming these difficulties. This led to the development of the first, usable prototype system [10]. While not sufficiently robust for wider dissemination, this provided a valuable platform to identify and trial solutions for many of the linguistic and technical issues, and it enabled our primary user family to get started which proved enormously helpful in defining the priorities for the development. We had intended to continue development beyond prototype stage, however practical difficulties arose in the level of technical support available, and it also became clear that we needed to have more control over the system and its features. This led to a decision to build our own native system entirely from scratch, which turned out to be fortuitous as *CoughDrop* has since then been sold commercially.

3. Geabaire: a custom-built, native approach

In the autumn of 2022, we embarked on building our own, native system, *Geabaire*. The requirements we set out for the development of the AAC system, based on users' feedback, were as follows [10]:

- I. Develop a bilingual AAC system which has good correspondence between the Irish and English versions. This is because users use spatial representations in memory to use AAC fluently [11], similarly to computer-users reliance on a motor plan when typing.
- II. The output should be grammatically correct. Being a morphologically-rich language, it is likely that a grammar-checker will be needed in Irish to achieve this.
- III. Be available offline and provide appropriate technical support to users.
- IV. Include a range of voices – children and bilingual voices included – which reflect users' identities.

A significant amount of technical work was necessary in order to design the system from scratch. This is in addition to the ongoing linguistic and voice-related work on the system. Though we have not achieved the requirements set out above in the current system, we have made some progress towards them. In relation to (I), we decided to start with Irish as the base language in our AAC system and plan to subsequently develop an English version. With that said, the bilingual requirements are a key consideration at every stage of development. In relation to (II), grammatical considerations are discussed in the text below. With regard to (III) and (IV), the provision of children's voices and bilingual voices are planned as part of the ABAIR initiative in the coming years and will be incorporated in due course. The following sections elaborate on the development thus far.

3.1 A design that captures the linguistic structure of Irish

Figure 1 shows *Geabaire*'s home board. Further boards are accessed by tapping any of the buttons on the home board which have a shaded lip on the top right-hand corner. Each sub-board within the homeboard reveals a semantically-related network which includes various forms of a verb, and words which tend to collocate with that verb (e.g. the board *clois* 'to hear', contains various forms of that verb in addition to words such as 'music' 'radio' 'sound' which are often occur with the verb.

Word order: Irish has a Verb-Subject-Object (VSO) word order (unlike the SVO order of English), and this is reflected in the homepage where the most common verbs (green) are placed to the left, followed by subjects (yellow), followed by objects (peach). As mentioned, the long-term intention is for the *Geabaire* system to be bilingual; the word order will remain the same in Irish and English insofar as possible, in order to preserve the motor plan across each language.

High-frequency phrases: the black buttons on the left margin provide access to high frequency materials and frequently used features. For example, *gob gasta* gives quick access to very frequent phrases such as "céan chaoi a bhfuil tú?" (how are you). The X and ? mark symbols provide access to the negative and the question forms of verbs: note that in Irish there are no terms 'yes' and 'no' (other than for the verb 'to be'), and so questions are responded to by echoing the negative or positive forms of the verb. Yes/no questions also require specific verbal forms. A keyboard is also included which contains the Irish long vowels with diacritics (e.g. <é>).

Prepositional pronouns: the lowest black button ('réamhfhocail') provides access to the prepositional pronouns, where prepositions e.g., 'le' (with) are combined with a pronoun e.g. 'mé' (me) to form a synthesised form 'liom' (with me). Given the prevalence of these prepositional pronouns in Irish, this button appears on all boards so that the user has quick access to them.

Inflections: Irish is a highly-inflected language, resulting in a large number of forms in the case of verbs, nouns, adjectives. Some of these inflections are catered for by the multiplicity of embedded boards, where the user can access verbal tenses. The various verbal forms are provided in the same sequence in the case of each verb. For instance, though the verb bí 'to be' and *clois* 'to hear' are on different boards, the past, present, future tense and verbal noun for each verb are in the same position on those boards. Again, this is to scaffold learning of the motor plan and to ensure buttons are easily accessible.

However, there are many types of inflections that cannot be accommodated in this fashion. For example, Irish, in common with the other Celtic languages, has mutations to initial consonants in specific grammatical contexts. One such mutation is called *séimhiú* (lenition), results in stops alternating with homorganic fricatives or being deleted. Another mutation *urú* (eclipsis), involves in the alternation of voiceless stops with homorganic nasals, and the alternation of voiceless stops with voiced stops. To deal with these and many other complex inflections, we will need to have recourse to a grammar checker. In our earlier *CoughDrop* prototype, the system connected to the An Gramadóir [12] grammar checker, and this was satisfactory for some but not in all cases, and a separate module for genitive case marking of nouns was implemented. We are hoping that further development of An Gramadóir – which will be useful for a range of resources and technologies - will facilitate a more robust treatment of the inflectional morphology of Irish.

4. Voices for Courses

Our voice is intimately linked with our sense of identity, and for the AAC user, it is critical that the voice is appropriate and that the user can identify with it. ABAIR's current TTS voices, although a relatively rich offering for an endangered language, is inadequate in order to accommodate the diversity of AAC users and respect their sense of identity. Children's voices are a particular need, and this is a priority for ABAIR's future work. In the meantime, we have two young female voices for Connacht and Ulster Irish which are relatively suitable for the younger user.

Ideally, in addition to children’s voices, we aspire to a system that can (i) be fine-tuned to a specific speaker, allowing for a group of non-speaking users in a classroom to differentiate themselves, and (ii) synthetic voices where vocal parameters can be manipulated by the user to vary tone of voice, so as to allow the user to express their emotion, mood and attitude. While research on voice quality is ongoing on the parallel projects Róbóglór/Glórcáil [13], these goals for the synthetic voices lie somewhere in the future.

5. Evaluation Plan

A series of iterative periods of evaluation of **Geabaire** is planned. The first stage will begin in the Autumn of this year and will involve the following groups:

- Users: **Geabaire** will be tested with users to evaluate the overall user experience including (i) suitability of voice options (ii) usefulness of features (iii) efficacy as a communication device, including latency (iv) acceptability of language e.g. grammatical accuracy (v) usefulness of features (vi) design and layout and vocabulary.
- Teachers and Speech and Language Therapists (SLTs): **Geabaire** will be tested with teachers in a classroom setting, and with SLTs in a clinical setting, to evaluate to what extent the system is usable and effective in these settings, with specific attention paid to the (i) layout and design of boards (ii) suitability of symbols (iii) efficacy of features e.g. *gob gasta* (iv) efficiency of vocabulary organisation (v) grammatical accuracy.
- Linguists: **Geabaire** will be tested with linguists in both a structured and unstructured context to examine (i) the robustness and naturalness of synthetic voices (ii) grammatical accuracy (iii) latency:
 - Structured: A list of 100 common sentences of varying length for children has been developed by a teacher and Irish language expert and participating linguists will be asked to produce the sentences using the AAC system and rate each one in relation criteria (i) – (iii) above.
 - Unstructured: linguists will be asked to produce novel sentences and to rate the output in relation to criteria (i) – (iii) above.

6. Future Directions

Our long-term goal is to develop a bilingual system which produces grammatically-accurate output, is available offline with a range of bilingual voices for users to choose from. A series of short and long-term goals are presented in this section. Note that at every juncture, AAC users will be part of the design and of the evaluation of the system.

In the short term, we have the following goals to optimise and finalise the Irish version.

- Extending the functionality of **Geabaire** is currently being planned. As mentioned, improving the grammatical accuracy of the output is important not only for the user but also to ensure that inaccurate forms are not being internalised by users, their classmates, friends and siblings.
- Children’s voices are needed to render AAC systems adequate to their young users, where it is not only an essential communication tool, but also the gateway to their language development, to their educational development and to their social inclusion. This is most urgent.
- Collecting – with permission – user data on the frequency of use of various buttons to inform future iterations.

In the medium- to long-term, we have the following additional goals

- The development of a parallel English system and its incorporation into a functional, bilingual system. Along with the anticipated issues, it is likely that unanticipated challenges (the ‘known unknown’) will arise in the development of the bilingual system. Alongside the development of the bilingual AAC system, bilingual voices will be developed as part of the ABAIR initiative for incorporation in the system.
- Accompanying training guides for stakeholders will be developed to scaffold learning of the system as well as best practice in using the system in educational settings.
- Future work will also encompass the personalisation of the synthetic voices so that each user can have a voice that matches their self-image. We are also exploring how we can manipulate source and filter features of the voice to allow a truly personal voice that can stay with a particular user. This would include having a voice that can ‘grow’ as the child grows [13].
- Highly desirable will be control over tone of voice, which could allow users to express themselves more adequately. Research towards this more distant aspiration is ongoing in the Laboratory on modelling voice modulation for affect expression [14, 15].

7. Conclusion

In this decade of indigenous languages, we are acutely aware of the need for technologies that cater for endangered and under resourced languages, and also cater for the minorities within the minority for want of technical supports are left without a voice in their own communities. We hope that sharing our journey, experiences, the challenges encountered and solutions adopted can be useful to other groups whose needs are similar to ours.

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