Development and evaluation of a mobile app to assist people with autism and intellectual disability to engage in social conversation

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Introduction
The social relationships and interactions of people who have autism spectrum disorder (ASD) and intellectual disability (ID) are negatively affected by their communication and cognitive difficulties. Difficulty in developing relationships can increase social isolation and affect mental health. This paper describes the development of a prototype mobile smartphone app designed to provide access to a range of conversational communicative acts for adults with ASD and ID. The app was designed to promote a 'no-failure' approach to participation in a simple conversation. It was evaluated with a group of people with ASD and ID.

Intended population
People taking part in these investigations included those who used communication supports such as symbol-based boards and planners. They had associated conditions including:

- cognitive impairment associated with ASD and difficulties in processing information;
- intellectual disabilities with difficulties in understanding others or in expressing themselves;
- literacy difficulties which might include some sensitivity about the use of language simplification.

Those with acquired conditions, such as aphasia and dementia, were not included in these investigations.

People with ASD have difficulty with social communication (Ganz, 2015) and demonstrate a restricted range of communication acts in conversation. The ability to make use of a range of communication acts is important in developing communication and having successful interactions. It is thus important to enable people with ASD to learn to use a wide range of communication acts in conversational situations (Logan *et al.*, 2017).

Of various types of intervention used with people with ASD and ID, research has indicated more support for aided AAC (Augmentative & Alternative Communication) than unaided AAC or manual signing. In comparison to people with ASD alone, those with ASD and ID benefitted from using speech generating devices (SGDs) and picture exchange communication (PECS) and benefitted particularly from using SGDs (Ganz, 2015).

Mobile smartphone technology and AAC
Many approaches have been explored in the development of aided AAC (Beukelman & Light, 2020; Newell *et al.*, 1995; Waller, 2018) and mobile smartphone technology offers certain advantages as a platform for AAC (McNaughton & Light, 2013). The devices are smaller and of lower cost than dedicated AAC systems, they give access to a range of applications, functionality and connectivity, are socially accepted and relatively easy to use.

Mobile AAC technology and people with ASD and ID
While most emphasis in this area has been on developing early skills to request or protest (non-interactive), less attention has been given to developing skills of socially-motivated communication such as story-telling and building social relationships (interactive). Of eight studies investigating the use of iPods® and iPads® with people with ASD and ID and complex communication needs, seven looked at requests and one at picture-naming (Kagohara *et al.*, 2013). There is scope for applying mobile technologies for a broader range of communication purposes, such as social closeness and information exchange (McNaughton & Light, 2013).

Design requirements
A prototype AAC app for people with ASD and ID was proposed, using smartphone technology as an AAC platform to address social communication and encourage the user to develop and use a range of conversational communicative acts. The app would involve the communication partner (Tsai, 2017), be easy to use and appropriate for naturalistic settings, matching challenges and skills of the user. The app was intended to foster a 'no-failure' approach to participation in a simple conversation, in that wherever the user tapped on the AAC

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To cite published paper: Jackson, K., Brophy-Arnott, M.B., Whittles, D., Stewart, N., & Arnott, J.L. (2021). Development and evaluation of a mobile app to assist people with autism and intellectual disability to engage in social conversation. *Communication Matters Journal,* 35:3, 22-25.

Presentation: presented at the *CM2019 International AAC Conference*, Leeds, England, UK, 8th-10th September 2019.

interface the conversation would progress, with the user guided ultimately towards a satisfactory conclusion to the interaction.

Design and development

Design followed WCAG 2.0 guidelines and evidence-based good practice in design for the target user group (W3C, 2008). Single button operation was used in the user interface, in order to limit the number of stimuli and options on the screen at any one time; too many options on the screen can be confusing for people with ASD (Elwin *et al.*, 2013). Symbols, images and words could all be used as communication elements.

Personas were used to assist the designers in understanding and communicating the needs of the target user group, with user journeys created to help visualise a particular path that the user might take when using the application. Ideas and questions arising as the user journeys were developed could be captured to assist the creative process. Initial visual representations of the user interface were produced using wireframes, assisting the design of interface features (e.g., layout, button size) in relation to user personas.

Content and stages

The content of the app was organised as stages in a conversation. The sequence of stages adopted for a basic interaction is shown in Figure 1, stemming from research on conversation modelling for AAC (Alm *et al.*, 1987; Murray *et al.*, 1991). The content was hence arranged into groupings for greetings, smalltalk, main section with stories, wrap-up remarks and farewells. Wait pages were included between stages to create pauses to encourage the user to turn-take during conversation. Example smartphone pages with pictograms for these stages are shown in Figures 2-to-7.

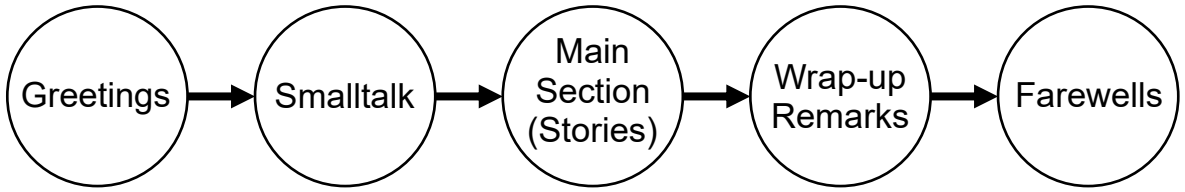

Figure 1: Sequence of five stages for a basic interaction (after Alm et al., 1987).

Functionality

The app opens on its home page (Figure 2), which shows a greetings button which occupies the whole width and most of the length of the screen, supporting the 'no-failure' goal of the conversation app with simplified touch interaction. The user and conversation partner can tap the screen on each page (stage); the conversation will step through its stages from greetings, to smalltalk, to the story options page (main section). Tapping once or making a long tap will act as input and trigger a change of screen. At each stage, an appropriate pre-recorded speech message will play to accord with the text on the on-screen pictogram, depending on selected settings.

Three stories were programmed into the app to form the default content of the main section. Each story consisted of a sequence of pages (images) for the user to step through by tapping the screen. The first default story was about going to a café with friends, the second was about a charity campaign in the city and the third was about a new museum in the same city. These three stories were selected to be topically relevant for local users. A user could choose which story to use from a three-item menu which appears when the main section is reached (Figure 4).

New stories with images can be programmed into the app via the Settings button should the user/carer wish to expand or personalise the available repertoire of stories. The Settings button is located at the foot of the home page and is clearly labelled so that it can be easily located in order to adjust optional settings. By navigating through settings pages, the user or carer has the facility to personalise audio, labels and images to adapt individual stories. Optional text labels can be set to appear on each of the conversation pages, above or below the image. New speech messages can be recorded to match individual pages.

Evaluation

Researcher Preparation

The researcher received specialist training and support, including work observation with Speech & Language Therapists (SLTs) and an SLT Health Care Support Worker (HCSW), in order to familiarise with the needs of people with ASD and ID. There was role-play with the HCSW showing how to interact with a person with ASD and ID, including strategies to manage any difficulties which might arise. Inclusive Communication training was also provided. A demonstration of the Talking Mat® method (Murphy & Cameron, 2008) was given with practice and guidance on how to carry out an evaluation with it.

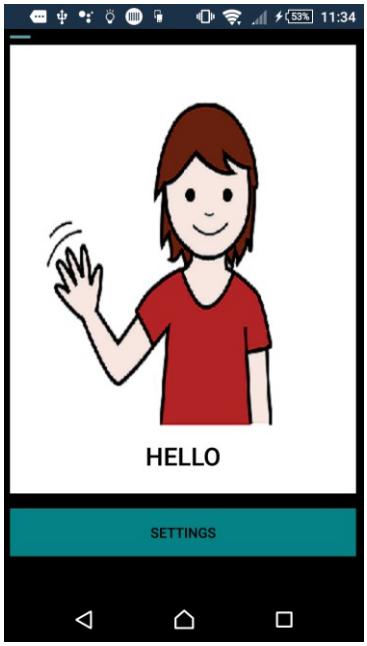

Figure 2: Home page, with Greetings stage & Settings button.

Figure 3: Smalltalk stage, to follow the Greetings stage.

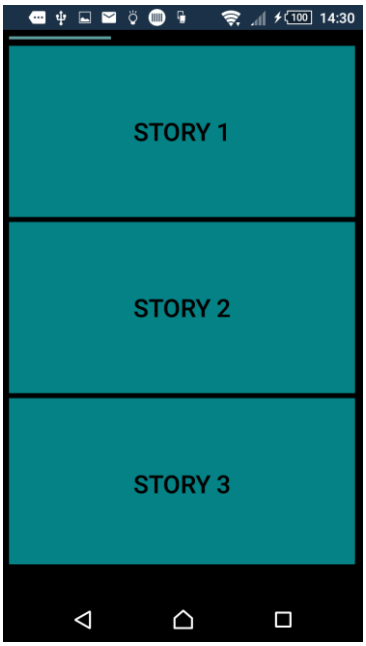

Figure 4: Main stage, with menu offering a choice of three stories.

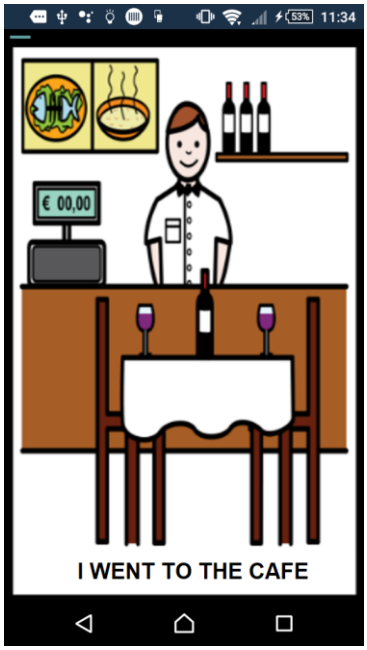

Figure 5: Main stage, with first page of Story 1: A visit to a café in the city.

Figure 6: Wrap-up remark stage, with Handshake pictogram.

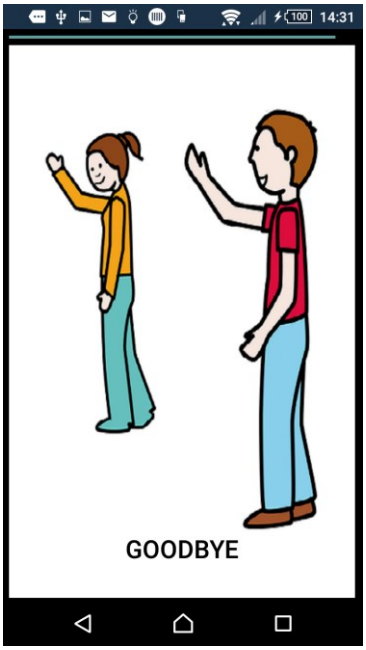

Figure 7: Farewell stage, with Goodbye pictogram.

Participants

An evaluation was conducted with five adult participants (P1-P5) with ASD and ID from a day-centre for people with ID. Symbolized information, consent and release forms were created for them. One carer from the same day-centre participated (P6) as the conversation partner throughout the evaluation. The study took place at the day-centre. Participants P1-P5 each had a practice conversation with the conversation partner P6 in order to familiarise with use of the app. P1-P5 then each held a second conversation with P6, which was video-recorded for subsequent review.

Feedback and Talking Mats®

A feedback exercise was conducted using a Talking Mats® approach (Murphy & Cameron, 2008) for gathering opinions regarding the app and its design. Participants P1-P5 were given the choice of using the Mat or a feedback form to express their views on the app; four participants (P1-P4) chose to use the Mat while one (P5) chose to use the feedback form.

Use of the Talking Mats® was recorded and photographed. The Talking Mats® completed by participants P1-P4 gave generally positive feedback. Most of their symbols were clustered on the left-hand ('happy') side of their Mats, with some in the central ('unsure') area and a small number on the right-hand ('unhappy') side, indicating that the participants were largely happy about aspects of using the app. Some concerns emerged about its appearance, the size of the screen and knowing what to do. Larger display screens, as on tablets, and further familiarisation with use of the app might help to resolve such concerns. A completed Mat® is shown in Figure 8.

Figure 8: A Talking Mat® from the feedback exercise.

Participant P5 described the app positively on their feedback form: "It's good because it can help problems". The conversation partner P6 (carer) was also asked for their view of the app; this they gave on a feedback form, indicating that the app was very easy to use, could be very beneficial for those unable to communicate verbally and also beneficial for those with less social skills as it would give them a choice of conversations (stories) to use. P6 concluded: "Overall … a fantastic app to have".

Video Analysis

Several aspects were observed on the video-recordings, such as conversation breakdowns (e.g. going off-topic, not understanding the conversation partner), the timings of interactions and the eye contact occurring between each participant (P1-P5) and the conversation partner (P6).

Conversation breakdowns: prompts to participants P1-P5 from conversation partner P6 were required on a total of 12 occasions in order to overcome pauses in proceedings. One participant required the majority of these prompts (8 of them) while other participants accounted for the remaining four. ***Eye contact:*** two participants tended not to give eye contact as they were concentrating on the screen before them, two gave eye contact when prompted by P6's response, while one gave eye contact after each page and increasingly at the wrap-up stage when asking questions. ***Timings:*** the time for most participants to respond and tap the screen varied from 0 to 3 seconds, although one took up to 30 seconds when selecting a story, even with prompting from P6.

Evaluation Summary

Overall, there was relatively little communication breakdown for all but one of the participants with ASD and ID and they were able to accomplish successful exchanges. Eye contact could be affected by participants concentrating on the screen rather than on their conversation partner. Timings varied, but usually not to a problematic extent. The mobile smartphone offered a suitable platform for this type of application, although larger displays, as found on tablets, might be preferred for some users, particularly those with sight limitations.

Discussion and Conclusion

A prototype AAC smartphone app was developed to promote engagement in simple conversation by people with ASD and ID. In evaluation, participants experienced successful interactions with a conversation partner (a carer) who also found the app useful and enjoyable. Conversation structuring in the app reduced challenges faced by participants, all of whom were able to complete interactions with the co-operation and encouragement of the conversation partner. The 'no-failure' theme meant that all participants with ASD and ID were guided by the

app towards appropriate completion of their interactions. Some prompting by the conversation partner was required in places, although this was not a big factor for most of the participants, and further practice in use might reduce this further. Inter-personal eye contact was limited due to participants concentrating on the display. While smartphones were a good platform for the application, larger displays (e.g. tablet screens) might be better for some users. The investigation was considered successful and gave positive indications for further exploration and development in this area.

Acknowledgements

The authors gratefully acknowledge the contributions of the participants in the conduct of this work.

Pictographic symbols used in Figures 2-to-7 are the property of the Government of Aragón, created by Sergio Palao for ARASAAC (www.arasaac.org) and distributed under Creative Commons License BY-NC-SA. Accessed via www.senteacher.org/symbolsearch/ .

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Citation

To cite published paper: see citation information in page **i** footnote.