Smart-speaker technology and intellectual disabilities: Agency and wellbeing

Abstract

Purpose: Mainstream intelligent personal assistants (IPAs, e.g., Amazon Echo, Google Home) offer an unprecedented opportunity to enhance agency and wellbeing among vulnerable groups across health and social care. However, unintended consequences and barriers to use are possible.

Materials and Method: We conducted a mixed-methods semi-randomised controlled trial among individuals with intellectual disability, providing IPAs to an intervention group (N=22), but not a control group (N=22). Semi-structured interviews on device use and daily life were conducted with individuals with intellectual disability. Observation surveys were also collected from support staff. Key themes were identified using thematic analysis. We also collected quantitative agency and wellbeing data. A separate group of 40 individuals who had already received IPAs were additionally assessed, as well as their support staff.

Results: Four themes were identified: 1. Social value, 2. Entertainment, 3. Perceived agency, 4. Challenges, perseverance, training/support needs. Opinions regarding IPAs were overwhelmingly positive. Most individuals qualitatively reported improved sense of agency and IPAs enabled many individuals to access features associated with wellbeing, but there was no significant change in the quantitative measure. Some individuals experienced challenges related to pronouncing and remembering IPA phrases, however perseverance was common.

Conclusion: This study increases our understanding of the ways smart speakers can be used to enhance life quality among individuals with intellectual disability, and the nature of barriers faced. In conclusion, IPAs are cost-effective complementary support for vulnerable populations, but additional training is required to realise all potential benefits.

Intellectual disability (ID) is characterized by impaired intellectual ability and challenges in daily functioning (ICD-10; World Health Organisation, 1992), often requiring a degree of support in everyday life. ID affects approximately 1% of the population (Maulik, 2011). The social care sector currently faces economic challenges that restrict support provision and access to bespoke assistive devices (Thorlby et al., 2018), which threatens the wellbeing and quality of life of people with ID.

The recent emergence of mainstream intelligent personal assistants (IPA; e.g., Amazon Echo and Google Home smart speakers) may offer an affordable and inclusive alternative to expensive bespoke technology, and a means to help improve quality of life across health and social care. IPA devices have a number of innovative functions that could enable vulnerable individuals to gain a greater sense of agency in their daily lives, and in turn increase their wellbeing. These include facilitating social interaction, setting reminders and alarms (e.g. for medication), accessing information and multimedia, and controlling aspects of the home environment (e.g. lights).

This study is the first to assess the outcomes of providing mainstream IPAs to individuals with ID, exploring the benefits or barriers that arise. Qualitative and quantitative data was collected, in a mixed methods approach. Two key questions were addressed: 1. What are the experiences and opinions of individuals with ID who are given IPA technology? 2. Do IPAs lead to quantitative changes in sense of agency and wellbeing?

How could IPA devices increase agency and wellbeing?

Individuals with ID often require support in daily tasks such as personal care, making plans, and accessing information and entertainment, which can threaten their sense of agency. Self-perceived agency is strongly related to wellbeing and mental health in individuals with ID (Ryan & Deci, 2000; Smith et al., 2000; Welzel & Inglehart, 2010). IPA devices could

increase agency because they allow individuals to control aspects of their daily life (e.g. entertainment, information, planning, communication).   In a recent review, Jamwal et al., (2020) found that smart home and communication technology may improve independence, quality of life and social participation for individuals with disabilities, particularly those with cognitive impairment. They suggested that technology was most useful when it fulfilled a broad purpose rather than addressing only one need, and was personalised and adapted to individual circumstance.

Smart speakers are a good example of a device that can serve with a whole range of functions and purposes, while also offering options for adaptability. Furthermore, rapid technological developments mean smart speakers are now affordable and accessible, and their mainstream nature could help to reduce stigma compared to bespoke assistive technologies which are often resisted (e.g., Parette & Scherer, 2004).   Large mainstream technology companies are also more likely to continually invest in updating their devices, unlike many bespoke technologies which are sometimes superseded by the time their effectiveness has been evaluated (Jamwal et al., 2020).

However, it also important to consider any potential barriers or limitations of smart speaker devices. Individuals with ID could have negative opinions about the devices or experience frustration using them. While many individuals enjoy the personification of smart speaker devices (e.g. Wallace and Morris, 2018; Purington et al., 2017), it has also been reported that some individuals find their "robotic voice" distressing (Doteveryone, 2019). It is also possible that there might be security and privacy concerns about using smart speakers. Previous studies evaluating other types of smart technologies have found that this is a common concern of support-staff and caregivers (Raghavendra et al., 2018, Ramsten et al., 2019). Interestingly, studies exploring smart technology with older adults have found they are often prepared to trade privacy for autonomy (Townsend et al., 2011).

Previous research on smart speakers in social care

In their review, Jamwal et al., (2020) highlighted a need for more rigorous and controlled studies in the area of smart home technology for people with disabilities. Broadly, evidence indicates a general utility and positive attitude towards assistive technologies in ID populations. A recent meta-analysis (56 studies) indicated positive effects of assistive technologies for education purposes, but did not explore smart technologies or daily living specifically (Perelmutter et al., 2017). A systematic review (22 studies) on assistive technologies for people with learning disabilities reported that the most common barriers to using assistive technologies was lack of funding/cost, lack of awareness and inadequate assessments (Boot et al., 2018). When comparing across populations, studies on attitudes and intentions towards smart technology tend to show that older adults and disabled groups are the most positive about these devices (e.g. Balta-Ozkan et la., 2013).

Very little research has explored the potential use of smart speaker devices specifically in social care, and even less for individuals with ID. Hampshire county council in the UK provided smart speakers to adults across the whole social care sector (i.e. with and without ID) (PA consulting, 2019) and reported that more than two thirds of users regained a degree of independence from using the devices. However, they did not differentiate between participants with and without ID and they did not include a control group who did not receive devices.

A small-scale pilot carried out by Innovate Trust, a charity providing supported accommodation for individuals with learning disability in South Wales, UK (Vass et al., 2018), placed an Amazon Echo in the homes of 5 individuals and reported improvements over a five-month period in self-reported sense of empowerment and independence.

A third study (Pradhan et al., 2018) examined online reviews of the Amazon Echo from the Amazon website, that included users with disabilities (visual, motor, speech,

cognitive and hearing impairments). Themes included increased independence and feelings of safety. Speech recognition for individuals with speech impairments was discussed as a challenge.

While none of these studies had a comparison group, they are consistent with the idea that mainstream IPA's have the potential to enrich daily life among individuals with ID. The three studies discussed above did not report any unintended negative consequences, though concerns have been raised elsewhere (Doteveryone, 2019).

Present research

This study assessed outcomes of providing mainstream smart speakers to individuals with ID via a semi-randomized controlled trial using a mixed methods approach. The findings indicated that mainstream smart speakers could offer a valuable avenue to enrich the lives of individuals with ID, as well as revealing barriers to use.

Method

The study was in collaboration with a local charity, Innovate Trust, who provide supported accommodation to individuals with ID living in South Wales, UK. The charity was in the process of planning a staged introduction of smart speakers to all of the houses accommodating individuals with ID that they support. As the roll-out of the devices was ongoing, we had the opportunity to run a semi-randomised controlled trial for the subset of individuals yet to receive devices, as well as including individuals who had already received devices in a supplementary cross-sectional comparison (see S5).

Participants

All individuals with mild to moderate intellectual disability were given the opportunity to

participate in the study. Individuals with severe intellectual disability were excluded, due to

lacking ability to provide fully informed consent. Ninety individuals with intellectual

disability were recruited via the charity to participate. Based on support worker reports a

number of these participants had specific conditions: Autism (N = 8), Down syndrome (N =

5), cerebral palsy (N = 4), acquired brain injury/stroke (N = 3), epilepsy (N = 3). However, it

is possible that some conditions were not reported, or were not known, by support workers.

Of the 90 participants, 48 did not have devices installed at the outset of the study and were

eligible to participate in a semi-randomised controlled trial. Participants were allocated to

groups using a semi-randomized design, where individuals within the same household were

allocated to the same group. Each of the 27 households was randomly allocated by the

supported living charity to either the control (N = 13 households, N = 25 participants) or

intervention (N=14 households, N = 23 participants) group via Excel, see table 1 for

demographics and figure 1 for study design.

The remaining 42 participants (in 24 households) already had devices installed in their

home at the outset of the study and were part of a cross-sectional comparison group (see

Figure 1).

-- Figure 1 about here -------------------------------------

Participants completed the verbal subtests of the Weschler Adult Intelligence Scale, Fourth

edition (WAIS-IV; Weschler, 2008), to provide a measure of verbal IQ. Due to time

limitations the full-scale WAIS was not administered. The verbal composite subtests

(similarities, vocabulary and comprehension) were administered to provide an indication of

verbal IQ (approx. 20 minutes). As outlined as an option in the instruction manual, we substituted the comprehension subtest for the information subtest since the wording of the comprehension items is more accessible for individuals with intellectual disability, with a focus on day to day knowledge (social situations and common concepts) rather than general knowledge. Additionally, the Matrix reasoning task from the WAIS was administered to obtain a measure of nonverbal IQ (5-10 minutes). Articulation difficulties did not influence the scoring of answers. Prescribed instructions for appropriate use with individuals with ID were followed.

Individuals with limited expressive verbal abilities or a preference to communicate non-verbally instead completed the Peabody Picture Vocabulary test (PPVT 4; Dunn & Dunn, 2007), which measures receptive vocabulary, with four multiple choice answer options shown pictorially, and allowing for pointing responses. Each set of items increases in difficulty. There are 12 items in a set, and upon answering 8 or more items incorrectly the assessment is discontinued.

Participants additionally completed the Matrix Reasoning subtest of the WAIS-IV, to measure their nonverbal ability. There were no significant differences between groups on the WAIS-IV VCI (verbal) ($F(2, 69) = .179$, $p = .837$, $\eta^2 = .005$), or the WAIS-IV MR (nonverbal) ($F(2, 67) = .230$, $p = .795$, $\eta^2 = .007$). See table 1 for descriptives and table 2 for statistical comparisons, broken down by group. The groups also did not differ in age, $F(2, 81) = .375$, $p = .688$, $\eta2 = .009$ (see also table 1 and 2). Two individuals did not complete any IQ/abilities assessments due to expressing a desire not to complete this component of the session/s. Both of these individuals were in the cross-sectional group.

-------------------------------------- Table 1 about here --------------------------------------

An additional 117 participants without ID, working as support staff were also included in the study, providing observational data regarding the participating individuals with ID that they support. These support staff ranged in age from 16-67 years.

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Measures

Wellbeing and Agency assessment

Wellbeing and agency of individuals with intellectual disability was assessed via self-report and support staff observation, collected via surveys with quantitative and qualitative components. The first part of the self-report survey was a new quantitative wellbeing and agency survey we developed for individuals with ID, inspired by the Warwick-Edinburgh Mental Wellbeing scale (WEBWMS; Tennant et al., 2007). We used simple wording of questions to aid understanding for participants with ID (see Supplementary materials S1 for full questionnaire). A number of items on the scale relate to agency (e.g., are you able to make your own choices). The scale takes approximately 5-15 minutes.

The support workers' observation surveys were developed by the authors, but again covered many of the same wellbeing items as the self-report surveys and thus items also inspired by the WEBWMS, as well as additional items that were included about specific aspects of day to day agency. The original WEBWMS has been found to have high internal reliability (Chronbachs alpha = 0.89), and high test-retest reliability (ICC = 0.83), see Tennant et al. (2007).

The second part of the surveys assessing wellbeing and agency (service user version and support staff version) were designed to elicit qualitative responses regarding good and bad aspects of participants' lives, as well as any difficulties they may be experiencing, and whether there are any new things they have been able to do. The questions in the qualitative survey were broad and open to allow themes to be identified inductively (see supplementary materials S2 for interview schedule).

Where possible the same support staff that completed the observational wellbeing and agency survey at time 1, completed the survey at time 2 for that same individual with ID. However, there were a number of instances (N = 19) in which this was not possible, due to absence or unavailability. In these instances, two support staff were asked to fill in a survey at time 2 and these responses were averaged, in an attempt to minimize the influence of any potential biases in opinions between different support staff. In a small number of instances (N = 6) it was not possible to obtain a completed staff survey at either time 1 or time 2 (N = 4 at time 1 (3 intervention group, 1 control group), N = 1 at time 2 (control group)).

Device use surveys

Device use surveys were developed by the authors to investigate service user opinions and support staff observations about the IPA devices directly, and based on surveys used in a pilot carried out by the supported accommodation charity (Innovate Trust).

Procedure

All sessions were carried out either at participants' own homes or at day centres, in a private quiet room except in rare unavoidable circumstances. The participants were informed that their decision to participate, or not, would not affect their day-to-day life or care. Participants were asked if they would like their personal support worker, or another staff member from

the charity, to be present during the session. The main researcher carried out the tasks with the participant.

In the first session, the background IQ measures, wellbeing and agency surveys were completed with the participant (as outlined in the measures section). This session took approximately 1 hour, or spanned across additional sessions where necessary/preferred. Individuals in the intervention group were provided with an IPA device (either an Amazon Echo or a Google Home) after their pre-test session/s were completed, while individuals in the control group were not provided with a device. Both groups were assessed at a second time point, ~12 weeks after the devices were installed for the intervention group, and after an equivalent time period without devices for the control group. At time two, the same assessments were repeated with the participants with ID. Support staff also provided observational data regarding the wellbeing and agency of individuals with ID at both time points, via surveys. In addition, opinions about the devices were assessed at time 2 for participants who had received devices (and their support staff). Individuals participating in the cross-sectional strand completed all measures only once.

Data Analyses

Missing and excluded data: For the controlled trial analyses, in instances where participants were unable to answer or declined to answer an item on the scale at one time point, then their response to this item on the scale was also deleted at the other time point (1 or 2), to ensure the same items were contributing to the average for that individual at both time points. The specific items missing responses and the number of missing responses were similar across the groups and few in number (see supplementary materials S3 for full details). If participants reported a potentially confounding circumstance, such as the recent death of a loved one (N = 1) or a life impacting operation (N = 1), their data was excluded from the relevant analyses

accordingly (N = 2 excluded for wellbeing analysis; N = 1 excluded for the agency analysis), however, including these participants did not change the pattern of results (see supplementary materials S4).

Qualitative analysis: Thematic analysis was carried out following the approach of Braun and Clarke (2006). The analysis was reflexive and inductive, with themes not limited to the data collection questions. The researcher read the transcribed data multiple times and made notes to ensure immersion in the data. The data was then inputted into NVivo qualitative data analysis software, after which the coding phase was initiated. The software was used to aid analyses due to the large body of qualitative data; allowing for organisation of the data and allowing the researcher to easily locate and reassess original sources of data contributing to different codes and themes. After identifying codes across the full data set, the researcher explored potential themes, with multiple codes contributing to a given theme. During this stage thematic maps were created to provide a visual overview of themes and the relationships among them. The themes and thematic maps were discussed with colleagues to determine whether the patterns and overall narrative resonated with others and whether interpretations were judged as meaningful and credible. The themes were reassessed multiples times and refined to ensure coherence, as well as to develop a meaningful story. The researcher referred back to the original codes and data sources repeatedly to ensure that the themes accurately captured and made sense of patterns across the data set. Each theme was given a label that clearly captured the contents and meaning of the theme. Multiple transcript extracts were selected to provide representative examples of the key components of each theme. All themes relating to experiences with IPA technology were derived from intervention and cross-sectional group data (participants who received IPA devices).

Results

1. **What are the experiences and opinions of individuals with intellectual disabilities who are given IPA technology?**

Four themes were identified from the interviews with individuals with ID who were provided with IPA technology, as well as their support staff (see Figure 2). Comments in the text are from individuals with ID unless explicitly labelled as support staff.

--------------------------------------- Figure 2 about here -------------------------------------

1. Social value

A social theme was identified in relation to device use. Personification of IPA devices was common with participants tending to refer to the Amazon Echo (Alexa) as "She", as well as attributing feelings to the device, e.g., "*I ask Alexa how she is doing today*", and "*She can talk to me things, it's very clever, she's got memory*". Individuals also enjoyed using the device to talk to, e.g., "*I like it because it says good morning and tells me about history and culture. Echo good night, and it says see you in the morning and I say it back, I say thank you*", "*I enjoy talking to it*", and "*It's nice to always have the company even though I do know she is a robot*". Thus, for some participants the device appeared to be used in the form of a social companion; this may be one reason why various individuals reported that they use the device when alone, e.g., "*(I) use it before the staff come*".

2. Entertainment and fun

Participants liked using features of IPA devices that provided them with entertainment, e.g., "*(I use the device) all the time for music*". One support worker commented that "*(they use the*

device for) music, jokes, weather, asks device to sing a song for them". Music was commonly

referred to, and individuals felt very positive about this feature, e.g., "*I love music*" and "*It

has all the music I want*". Music was the most commonly reported feature that participants

reported using, which is presented in Figure 3 later in the manuscript. It appeared that

individuals like the ability to access these entertaining features with ease (i.e., the simplicity

of just asking): "*I just talk to it, echo tell me a joke, echo, play me a song*" and "*I find it

easy*". Having access to entertaining features such as music at any time of day was also

discussed, for example: "*I can listen to radio when I'm in bed*", and "*being able to play music

whenever I like*". Therefore, many individuals were able to access entertainment more easily,

and thus potentially more often than they did prior to having the device.

3. Agency and positive perception of ability

3a. Sense of agency in relation to device use. Many individuals reported being able

to use the device and having a sense of agency in relation to device use was discussed

positively, for example "*(I) like being able to do it myself*"", "*I like being able to ask for

things myself*"". This was also reflected in comments from some support workers: *"Definitely

makes them feel more independent*". This included references to having control from both

individuals with a intellectual disability, "*Gives me control of alarms*", and from support

workers, "*(they) like being in control of music"*. As touched on in relation to the

entertainment theme, individuals appear to like the element of choice (i.e., agency) regarding

when they can access features: *"(use) whenever I feel like it"*. After playing music, the next

most frequently used device features were accessing information such as facts/dates, (e.g. "*I

ask it loads of questions*", "*ask weather, ask day, history*") and asking for the weather

forecast, both reflecting an independent ability to acquire knowledge. Individuals also

discussed the device allowing them to do certain tasks/skills themselves that are associated

with independence, such as settings reminders and telling the time: "*reminder for taking tablets, I set it*", "*I can tell the time on it, I ask it*". Additionally, staff commented on setting up reminders so that individuals can be informed about their plans for the day: "*Staff enable the device to remind service user of specific times of activities which he/she often requests*", this indicates that the devices can supplement support, allowing individuals to be less dependent on staff in these instances. As previously noted under the social value theme, some participants with intellectual disability use the device without help when they are alone (i.e., independently).

3b. Positive perception of ability among people with ID. We also found that individuals with ID had a positive perception of their ability, focussing on what they *can* do, and emphasising that they only need *some* help with *some* things. For example, *"(I need) help in using it to its maximum potential, (but I) can do some things without help*", and "*(I need help) getting it to do the things that I ask, but I'm good at remembering how to use it*". These perceptions appear to be optimistic relative to staff perceptions, as will be illustrated below in results for Question 2. This positive perception is indicative of a desire for agency and/or to be viewed as independent, further highlighting the potential value of IPA's in increasing this sense of agency. It also implies that, for a number of individuals, experiencing a degree of difficulty did not deter them from using the device.

4. IPA challenges, perseverance, support and training

While many individuals felt positively about their ability to use the device, there were some challenges experienced – often noted by support workers – with a need for support and potential value of future training for using devices also identified as a theme.

4a. IPA challenges: Speech intelligibility and remembering phrases. Some

individuals experienced speech/intelligibility challenges, with the device not recognising their

commands, for example: "*doesn't pick me up saying certain radio so support worker asks it*".

Similar problems were also reported by support staff, who said it could lead to frustration,

"*Service user gets frustrated using device as it doesn't always pick up their speech*". Support

staff also commented that some individuals found it difficult to remember phrasing for the

device, primarily this involved forgetting to say the wake word prior to their command, for

example: *"(needs) prompts to activate it, forgets to say 'OK Google'"*.

4b. Perseverance. However, perseverance was also discussed in relation to

overcoming difficulties communicating with the device, for example: "*Staff have been trying

to help me say Alexa. (I'll) get there in the end*" and "*I can do it. Sometimes it works. I can

ask her things but someone else has to say 'Alexa' first*". This shows that for individuals who

do experience speech/phrasing difficulties it does not always deter them from attempting to

use the device. This may reflect a strong desire to use the device, as indicated by other

comments: "*service user likes the device and wants to use it, sits next to it and looks at it a lot

and tries to use it, but problems at present' (due to pronunciation of 'Alexa')*". Comments

from support staff indicated that this perseverance may pay off with individuals getting better

with practice, and also appearing to learn to speak more clearly, e.g., *"As service user has a

speech impediment, having the device seems to encourage them to speak a little slower and

clearer".*

4c. Lack of awareness indicating need for support and training. Some individuals

were unaware of the capabilities of the device, or did not know how to use it, for example:

"*It's just there. Don't know what it can do*", and "*Have never used it. Don't know how or if I

can*". Therefore, lack of awareness appears to prevent or deter individuals from using the

device, despite the fact that they may be able to use the device and may enjoy it (as indicated

by the positive opinions of the wider sample). Other comments indicated that some individuals felt that they were not using the full potential of the device, and could potentially get more out of it, e.g.: "*I don't know what else it can do. Just gives you information*". Some support staff reported similar problems, *"(they) are not aware of its full capabilities"*. Again this implies that individuals could potentially use the device more and get more from it if their awareness of all features was increased via training. As well as a need for more awareness, a reliance on help from staff was also apparent. Individuals who experienced difficulties tended to discuss getting support from staff in order to use the device, for example: "*(I need help) getting Alexa to respond to me. Help from support worker to pronounce*".

Which features of the smart speaker did participants report using?

Participants in both the intervention (N = 23) and cross-sectional (N = 40) groups were asked which features of the smart speakers they used. These results were collated and are shown in Figure 3. Music was the most popular feature across participants and was used by most people. However, a range of other features were also used by participants, including those related to daily planning and control of the home environment.   It is important to note that across the two groups, six of the 63 participants reported that they did not use any device features.

--------------------------------------- Figure 3 about here -------------------------------------

Question 2. Do IPAs lead to quantitative changes in sense of agency and wellbeing?

Device use questionnaires

Data from the questionnaire about device use are shown in table 3. We found that 80% of individuals who received IPA devices reported feeling better able to do things for themselves as a result of device use. Individuals with ID had higher perceptions of their ability to do things for themselves as a result of having devices, compared to staff perceptions, with only 27% of staff reporting that individuals felt better able to do things for themselves.

As with the perceptions of ability, the individuals with ID felt that they needed less help with regards to device use, relative to staff observations, with 27% of individuals with ID reporting the need for help, in contrast to 59% of staff reporting that individuals needed help to use the device.

Furthermore, 79% of participants with devices liked using them. This percentage was slightly lower for staff, with 58% observed as liking to use the device. There were a minority of cases (25%) in which the device was reported by individuals with ID as causing them frustration, and 26% based on staff observation.

--------------------------------------- Table 3 about here ---------------------------------------

General agency and wellbeing

We investigated whether having an IPA device led to a significant group level increase in general (i.e. not specifically device related) self-reported agency and wellbeing. A mixed ANCOVA was carried out on agency data from the quantitative questionnaire, with one between subject's factor: group (intervention, control), and three covariates: pre-test agency (continuous), gender (female, male), and age (continuous). The dependent outcome was self-reported agency at post-test. The main effect of group on perceived agency at post-test was not significant ($F(1, 38) = .28$, $p = .60$, see figure 4A. This analysis was repeated with staff-

report of individuals agency and again, the main effect of group on agency was not

significant ($F(1, 32) = .69$, $p = .41$), see figure 4B. The cross-sectional comparison was also

non-significant (self-reported, $F(1, 83) = .169$, $p = .682$; staff reported, $F(1, 80) = .537$, $p = .466$). Cross-sectional comparison figures are shown in supplementary materials S5.

We also investigated whether having a device led to a significant group level increase

in self-reported wellbeing. A mixed ANCOVA was carried out on wellbeing data from the

quantitative questionnaire, with one between subject's factor: group (intervention, control),

and three covariates: pre-test wellbeing (continuous), gender (female, male), and age

(continuous). The dependent outcome was self-reported wellbeing at post-test. The main

effect of group on wellbeing at post-test was not significant ($F(1, 37) = .11$, $p = .74$, see

figure 4C. This analysis was repeated with staff-report of wellbeing for individuals with

intellectual disability and was again not significant ($F(1, 32) = .001$, $p = .98$), see figure 4D.

The cross-sectional comparison was also non-significant (self-reported, $F(1, 83) = 1.364$, $p = .246$; staff reported, $F(1, 80) = .705$, $p = .404$), see supplementary materials S5 for the figure.

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Discussion

This study investigated two questions: 1. What are the experiences and opinions of

individuals with ID who are given IPA technology? In sum, participants had positive

opinions about IPA technology, enjoying access to entertainment and information, as well as

experiencing an increased sense of agency. There were difficulties with speech intelligibility,

remembering phrases, and awareness of how to access different device features. However,

there were also reports of overcoming these challenges over time, and these difficulties could

be further addressed with training approaches. 2. Do IPA's lead to quantitative changes in

sense of agency and wellbeing? Despite the qualitative improvements in sense of agency and wellbeing, the quantitative tools we used did not show significant changes at the group level.

These findings highlight the potential of IPA devices to improve perceptions of wellbeing and agency, and may be relevant for other vulnerable groups facing similar barriers.

Experiences and opinions about smart speakers

Individuals with ID tended to feel positively about IPA devices, with a large majority reporting that they liked using the devices, and that the device made them feel better able to do things for themselves. Two key themes identified were the value of 1. Social Factors and 2. Entertainment/Fun. The devices provided 'someone to talk to' within the home, and some individuals found this to be particularly appealing when they were alone. Previous research has found that people in general enjoy the personification of smart speaker devices and this often correlates with usage (e.g. Wallace and Morris, 2018; Purington et al., 2017).

The devices were also used as a source of entertainment within the home, primarily music, but also jokes and games. Listening to self-selected music has previously been shown to reduce feelings of stress and anxiety (Groarke, Groarke, Hogan, Costello & Lynch, 2019), this may contribute to individuals' enjoyment of such features. The devices do not appear to replace individuals' enjoyment of going out socialising and participating in various activities, which were key elements that contributed to quality of life for individuals with ID in all groups, regardless of IPA devices.

Effects of smart speakers on agency

A large majority of individuals reported that the IPA device made them feel better able to do things for themselves. Primarily individuals used the devices to access

entertainment and/or information (e.g., facts, weather forecast) themselves, and to a lesser extent to control their environment (e.g., lights). However, across the qualitative and quantitative data there was a discrepancy between self-report and staff report. Staff reported that more help with IPA use was needed than the individuals themselves. Staff may be considering the prompts required (e.g., to use the device), whereas the individuals may feel that they can use the device despite needing a little bit of help.

While some participants with ID appeared to be very comfortable with receiving help, noting that they like to ask their support worker to help them use the device, others appeared eager to emphasise that they did not need help for using devices. This may indicate a strong desire for agency among individuals with ID. In general, individuals with ID may be more inclined to be optimistic and focus on what they *can* do, potentially overestimating their abilities (see Klassen, 2002 for a review). Optimism and self-determination are strongly correlated among individuals with ID (Shogren et al., 2006). We also found that some individuals used the device when alone, thus staff would not witness all device use.

Despite this reporting discrepancy, it is important in its own right that individuals with ID perceived that they were able to do things themselves. This aligns with reports of improved independence associated with smart speakers and smart technology among individuals with more general disabilities (Pradhan et al., 2018; Jamwal et al., 2020). At a quantitative group level, there was not a significant increase in self-reported or staff-reported sense of agency more generally (overall ability to make choices, do things yourself, and ability to cope with problems). The measure may be insensitive to specific changes, or the device usage may have been too varied or limited in time and scope to produce a group level effect.

Wellbeing

While individuals with ID enjoyed using the devices for social interaction and entertainment, both of which were also discussed as positive aspects of life more generally, the group level effect for quantitative wellbeing was not significant for the ~12 week period that they had the device. Previous research indicates that self-report wellbeing tends to remain very stable over time (e.g., Hudson et al., 2016), and for the majority of people it changes only in the face of significant life events (Headey & Wearing, 1989; Headey, 2006), so receiving the IPA device may not have been a substantial enough change. It is important to acknowledge that there was variation across individuals in their use of the IPA devices, which may have limited the group level effect, which may require longer and more consistent use for a significant group effect to emerge. During this ~12 week period, individuals were learning to use the device, with prompts needed and some difficulties faced (e.g., intelligibility and phrasing).

Intelligibility and phrasing challenges

Speech and phrasing were common challenges faced in relation to device use, which is unsurprising given that language difficulties, speech impediments and memory difficulties are common among individuals with ID (Coppens-Hofman et al., 2017). However, individuals often persevered, suggesting a strong motivation to use the device. This is consistent with research on assistive technologies in other populations, where users are often motivated to persevere using devices, and this perseverance correlates with device use and enjoyment (e.g. Myburg et al., 2015; Zapf et al., 2015; Kerkhoff et al., 2020)

Despite this, speech difficulties and forgetting phrasing were the main reasons for the relatively small number of instances when participants felt frustrated with the devices. However, these same participants still tended to report liking the device overall, and a majority of participants reported no frustrations. With memory challenges in day to day life

more generally (e.g., remembering tasks/plans) arising as one of the main challenges faced by individuals with ID, it highlights that features of IPA devices to support memory (e.g., reminders and morning updates outlining plans for the day) could lead to further benefits if encouraged in future, particularly given that difficulty remembering was a source of frustration and anxiety.

Training, support and future directions

Based on qualitative data from both staff and individuals with ID, it was apparent that the availability of systematic training to ensure individuals can access all desired features of the IPA device (e.g., reminders, video calls, shopping lists), including awareness of how to phrase verbal commands, is needed to further enhance IPA use and benefits.   As some individuals were resistant to help, training would need to be provided in a sensitive and optional format. The importance of ongoing training, assessment and support are commonly emphasised within the area of assistive technologies in order to reduce barriers to use (Steel et al., 2017, Jamwal et al., 2020, Adolfsson et al., 2016; Boot et al., 2018). Our study sits well within this past work and stresses the importance of developing accessible and adaptive training and support for users.

Furthermore, future research should focus on tailoring devices to individual needs, for example, by installing unique features or ways of operating the device that are adjusted to the individual. For individuals who shared one device in a communal space, device use and associated benefits may increase further if they are provided with a personal device in their own room. A review by Jamwal et al., (2020) suggested that smart technology is more effective when it is adapted to individual need and serves more than one purpose. Mainstream smart speaker technology is able to offer users a wide range of different features for varied aspects of daily living.

Importantly, we found no negative consequences of device use. Previous research has found that privacy and surveillance concerns about smart technology are common in support staff and caregivers of people with disabilities (Raghavendra et al., 2018, Ramsten et al., 2019). However, we did not find these concerns were common in our participants. We also did not find evidence of fear of the device/robotic voice or dislike of technology in general. This highlights that the ID population feel positive and open to this new technology. However, education surrounding privacy and data sharing should always be considered when introducing any modern technology in social care and clinical settings.

The inclusive nature of mainstream IPA devices may have contributed to individuals with ID being eager to use the device to help themselves, where they may not feel that they are being given the device as a support tool but rather a fun piece of technology to try out. Adaptations to allow use of IPA devices among individuals who are nonverbal or have extremely limited verbal abilities are also important to allow full inclusivity in future.

Limitations

One important limitation of the study is that we were not able to record device use statistics (due to potential ethical issues). This information would have provided a useful context for interpreting the findings and explaining any individual differences or temporal effects (e.g. did device use increase or decrease over time). Furthermore, low device use among some participants is a potential reason for the lack of differences in the general, non-device specific measures of wellbeing and agency. In future studies it would be useful to collect this information.

The study was limited in scope to individuals with the necessary communication abilities to interact with both the researcher and the smart speaker device. This means that individuals with more severe disability, who are an under–researched group, were not able to

take part. Future research could examine whether individuals with more severe disability would benefit from smart technology and if new ways to communicate with the devices are developed.

The study was also limited to individuals with intellectual disability who lived in one geographic area (South Wales, UK) and who received support from the same service provider (Innovate Trust). To ensure generalisability of the findings, we would look to replicate the study in other populations.

Conclusion

In the first controlled trial to explore the use of IPA devices among individuals with ID, we found that overall opinions were positive, and individuals felt the devices led to improvements in factors associated with quality of life (e.g. access to entertainment and social interaction) and also enabled them to do more things for themselves. The only substantial barriers to use among a subset of participants were speech intelligibility and phrasing, however perseverance was also shown in attempting to speak to devices.

We did not find evidence of group level changes in agency and wellbeing over the ~12-week period of the study. This could be attributed to large individual differences in the amount individuals used the devices. Over a greater period of time, with systematic training and full access to all features, group level changes in agency and wellbeing may reach a significant level.

The affordability and inclusive nature of mainstream IPA devices, along with the promising outcomes of this study indicate that smart speakers are a valuable tool for individuals with ID. Furthermore, the findings are relevant to a range of groups across health and social care who also face barriers in agency, wellbeing and quality of life (e.g., dementia,

autism, physical disabilities). It appears that vulnerable populations have a great deal to gain

from this technology as it rapidly evolves.

Acknowledgements

Disclosure of Interest

The authors report no conflict of interest.

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Table 1. Descriptive statistics (Mean, Standard deviation (SD) and Range)) for chronological age and each IQ/abilities assessment for each group

	N	*Mean ± SD*	*Range*
Chronological Age (years)			
Intervention group	22	45.3 ± 13.7	22-69
Control group	22	48.6 ± 16.9	22-82
Cross-sectional group	40	45.7 ± 13.1	27-74
WAIS-IV verbal			
Intervention group	20	59.05 ± 8.54	50-76
Control group	16	57.31 ± 6.80	50-72
Cross-sectional group	36	58.44 ± 9.55	50-87
PPVT			
Intervention group	2	32.50 ± 12.02	24-41
Control group	6	43.33 ± 23.29	20-77
Cross-sectional group	2	32.50 ± 12.02	24-41
WAIS-IV Matrix reasoning			
Intervention group	19	3.11 ± 1.29	1-5
Control group	19	3.47 ± 2.32	1-9
Cross-sectional group	32	3.41 ± 1.76	1-8

Note. WAIS-IV verbal composite index: norm of 100, SD = 15; WAIS-IV Matrix reasoning subtest: norm of 10, SD = 3; PPVT: norm of 100, SD = 15.

Table 2. Statistical comparisons of age and IQ (WAIS-IV) across the three groups, showing

no significant differences.

	Age	*WAIS verbal*	*WAIS matrix R*
Intervention vs control	$t(43)$ = -.565, *n.s.*	$t(34)$ = .662, *n.s.*	$t(36)$ = -.606, *n.s.*
Intervention vs cross-sectional	$t(61)$ = .100, *n.s.*	$t(54)$ = .236, *n.s.*	$t(49)$ = -.649, *n.s.*
Control vs cross-sectional group	$t(60)$ = .764, *n.s.*	$t(50)$ = -.428, *n.s.*	$t(49)$ = .117, *n.s.*

Table 3. Percentage responses from service users and staff for the quantitative survey on device use.

Question	Self-report (%)				Staff observation (%)			
	Yes	No	I don't know	Some-times	Yes	No	I don't know	Some-times
Does the device make you/them feel better able to do things for yourself/themselves?	80	16	4		27	63	4	6
Do you/they need help using it?	27	70	3		59	37	4	
Do you/they like using the device?	79	13	8		58	30	12	
Does the device frustrate you/them?	25	70		5	26	59		15

Figure 1. Flow diagram showing participant allocation and progress through study

Social value	Entertainment and fun
• Personification of device • Someone/something to talk to (social companion) • Use of device when alone	• Popularity of entertaining features e.g. enjoyment of music • Accessing entertainment with ease • Accessing entertainment at any time of day
Agency and positive perception of ability • Sense of agency in relation to device use • Positive perception of ability among people with intellectual disability in relation to device use.	**IPA challenges, perseverance, support and training** • Challenges with speech intelligibility and remembering IPA phrases • Perseverance • Lack of awareness indicating need for support and training

Figure 2. Summary of the four themes identified in relation to experiences and opinions of
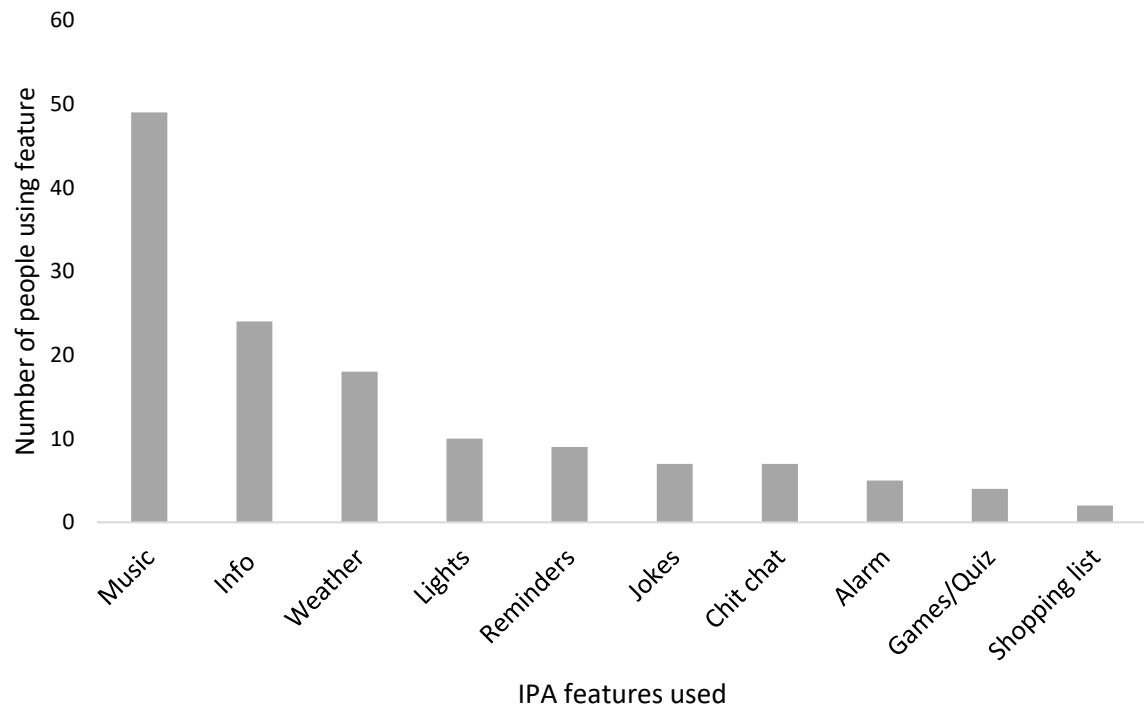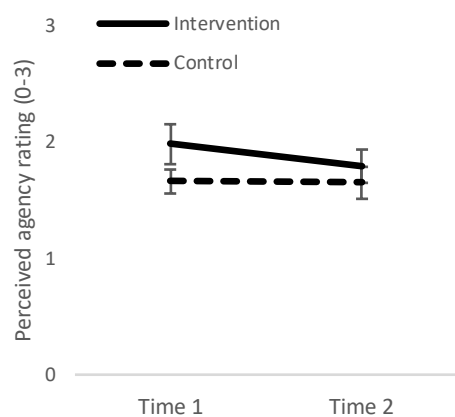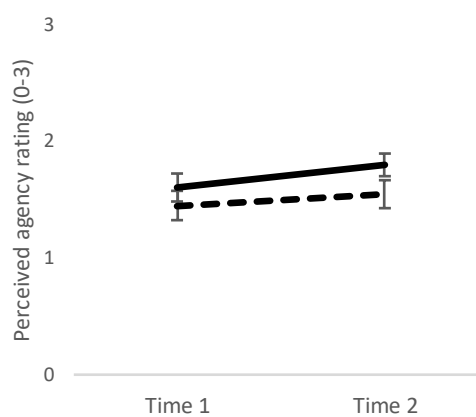
IPA use.

Figure 3. Frequency of device features used, based on self-report responses from individuals in the experimental group (N = 23) and the cross-sectional group (N = 40), (Combined total N = 63).
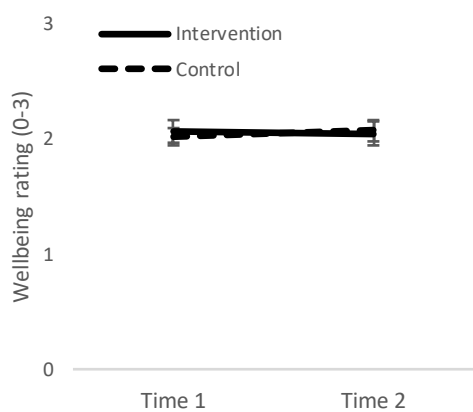
A. Self-report

B. Staff observation
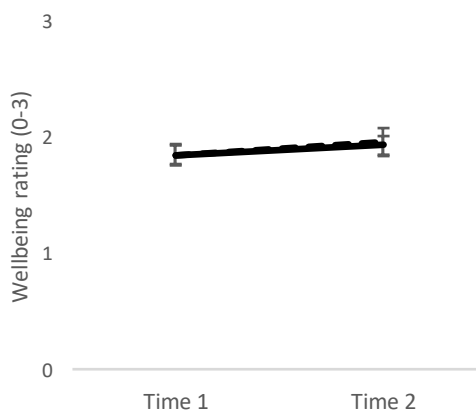
C. Self-report

D. Staff observation

Figure 4. Top left panel (A) shows self-reported agency, top right panel (B) shows staff observed agency for intervention and control group, across the two time points. Bottom left panel (C) shows self-reported wellbeing, bottom right panel (D) shows staff observed wellbeing for intervention and control group, across the two time points. Error bars represent +/- 1 standard error.

Figure captions

Figure 1. Flow diagram showing participant allocation and progress through study

Figure 2. Summary of the four themes identified in relation to experiences and opinions of IPA use.

Figure 3. Frequency of device features used, based on self-report responses from individuals in the experimental group (N = 23) and the cross-sectional group (N = 40), (Combined total N = 63).

Figure 4. Top left panel (A) shows self-reported agency, top right panel (B) shows staff observed agency for intervention and control group, across the two time points. Bottom left panel (C) shows self-reported wellbeing, bottom right panel (D) shows staff observed wellbeing for intervention and control group, across the two time points. Error bars represent +/- 1 standard error.