Disability and Rehabilitation: Assistive Technology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/iidt20

Augmented reality: a view to future visual supports for people with disability

Lucy Bryant & Bronwyn Hemsley

DISABILITY AND REHABILITATION: ASSISTIVE TECHNOLOGY
https://doi.org/10.1080/17483107.2022.2125090

Taylor & Francis
Taylor & Francis Group

ORIGINAL RESEARCH

OPEN ACCESS Check for updates

Augmented reality: a view to future visual supports for people with disability

Lucy Bryant[a] and Bronwyn Hemsley[a,b]

[a]Faculty of Health, University of Technology Sydney Graduate School of Health, Sydney, Australia; [b]Faculty of Education and Arts, University of Newcastle, Newcastle, Australia

ABSTRACT

Background: Augmented reality (AR) technologies may provide immersive visual supports that foster active user engagement in activities. However, there is little research examining the use of AR as a visual support to guide its use in research or therapy settings.
Aims: To investigate the development and use of AR for delivering visual supports in an immersive environment, using the Microsoft® HoloLens2® and Microsoft® Dynamics 365 Guides® software.
Method: In a duo-ethnography, two speech-language pathologists who were novice users of the HoloLens2®, examined the affordances of the device for potential use in future research with people with neurodevelopmental disability. In a proof-of-concept study, an AR application was designed by the first author and used by two researchers in a duo-ethnography. The first and second author tested the AR guide and reflected on opportunities and barriers to further use of AR technology, specifically the HoloLens2®, to support people with disability to participate and be included in meaningful activities.
Results: The guide created provided situated visual instructions, video models, and holographic symbols to direct the second author in making of a cup of tea. While a moderate level of technological literacy was needed to establish and install a guide, effective use could be established with minimal training.
Discussion & conclusions: AR guides offer a situated and integrated means of providing visual support to people with disabilities. This proof-of-concept study justifies further testing and evaluation of AR as an assistive technology for people with neurodevelopmental disability.

ARTICLE HISTORY
Received 7 December 2021
Revised 28 July 2022
Accepted 11 September 2022

KEYWORDS
Visual supports; augmented reality; AR; neurodevelopmental disability

➤ IMPLICATIONS FOR REHABILITATION

- Emerging immersive Augmented Reality technology provides new opportunities to create integrated visual supports that function within the user's environment to enable active participation in activities and interactions.
- Visual supports integrated with the user's environment may better support people with disability to actively engage and attend to objects and to their communication partners.
- While new and emerging technologies like Augmented Reality are largely untested for disability support, they offer opportunities to enable participation in independent activities.

Introduction

For millions of children and adults globally with significant communication disability, augmentative and alternative communication (AAC) systems and strategies, including visual supports, provide a means to interact with the world around them [1]. Such communication supports are integral to social, communication, educational and occupational participation, particularly for people with neurodevelopmental disabilities [2,3]. People with neurodevelopmental disabilities, such as autism spectrum disorder (ASD), Down syndrome, cerebral palsy, and developmental language disorders often have impaired receptive and expressive language [4] affecting their ability to interact with others, learn new skills, and learn adaptive skills.

Visual supports are a dynamic and versatile means of supporting children and adults with disability to attend, understand the physical and social environment and abstract concepts, and express ideas [5–9]. Both visual supports and AAC systems provide visual stimuli, usually in graphic form, to enhance the comprehension and learning of people with communication disability and are particularly common for children with autism [5,10]. A scoping review of visual supports for people with ASD (up to the age of 44) identified 34 studies investigating the use of visual supports at home [7]. The review suggested that visual supports positively affected the behaviour and communication of users, helping them to interact with other people and their environments consistently. Additionally, intervention studies implementing visual supports reported that users of visual supports were more independent, less anxious, and were better able to communicate with parents or caregivers [7]. An integrative systematic review of AAC use by children with ASD highlighted the barriers and facilitators to successful use of visual supports, along with low-tech and high-AAC tech systems to support communication [11]. This review of 42 studies highlighted that the success of visual supports and AAC systems relied on personal, environmental, and device-related factors; including attitudes towards devices, their simplicity to maintain,

CONTACT Lucy Bryant Lucy.Bryant@uts.edu.au University of Technology Sydney Graduate School of Health, 100 Broadway, Chippendale, 2007, NSW, Australia

and their ability to integrate into the child's environment to support rather than hinder attention to communication partners.

Visual supports as a form of visual language

Given the predominantly visual modality required to access visual supports and AAC systems, Shane and colleagues [3] outlined a framework for "visual language" that includes three modes: visual expressive mode (for expression), visual instruction mode (for comprehension), and visual organisation mode. Zimmerman, Ledford, Gagnon, and Martin [12] described two types of typical classroom visual supports that aligned with Shane and colleague's visual instruction mode of visual language: visual activity schedules that illustrated a daily calendar or sequence of events for the purpose of planning, and structured visuals that provide guidance to support participation in specific activities while the activity is in progress. Social stories and visual support interventions for children considered at risk of emotional and behavioural disorders, implemented in pre- and primary-school classroom settings alongside instructional activities, indicate that visual supports are effective in improving overall student engagement, and continued presentation of visual supports appeared to improve the consistency of students' performance [12].

However, there is also often some lack of integration between communication supports and a user's environment that may encourage passive engagement in communicative environments, rather that active participation [1,11]. New and emerging technologies are integral to the use of visual supports and AAC systems into the future [1,3]. Following the development of mobile devices and smart-watch technologies [13], Schlosser and colleagues [14] trialled Apple Watch® technology to determine the feasibility of using wearable devices to provide "just-in-time" visual supports for children with ASD and intellectual disability. In an experimental case study design, the researchers observed whether the provision of visual supports resulted in successful completion of a tabletop task. The children appeared to benefit from static and dynamic scene displays and the Apple Watch® was deemed an effective, unobtrusive, and discreet means of delivering visual supports.

Augmented reality to deliver visual supports

Augmented Reality (AR) is another growing technology that might support greater integration of communication supports and the environment. AR technology overlays computer-generated graphics onto the physical environment of the user to modify or augment what they see. These graphics may be holographic objects or avatars, or instructional imagery including written words, graphics, or videos [15]. The augmented environment is created when the user views their immediate surroundings through a digital device, such as the camera on a smart device (e.g. a smart phone or table), or through a head-mounted computer display, sometimes called AR "glasses" (e.g. Microsoft® HoloLens2® or Google Glass®). An AR head-mounted display provides added benefit through hands-free viewing of the augmented world. As such, the user does not need to hold a smart device and is therefore immersed in, and free to interact with, their environment. The wireless device houses a small computer for projecting visuals onto a transparent lens (at the front), and a battery (at the back), all held in place by an adjustable head strap (see Figure 1).

Augmented reality research in populations with neurodevelopmental disability

Although AR may support the delivery of integrated visual supports for people with disability, to date there is little exploration of this in the AAC or ASD literature. AR technologies have been used to provide visual supports on a phone screen using the device camera to overlay instructions onto the real world [16].

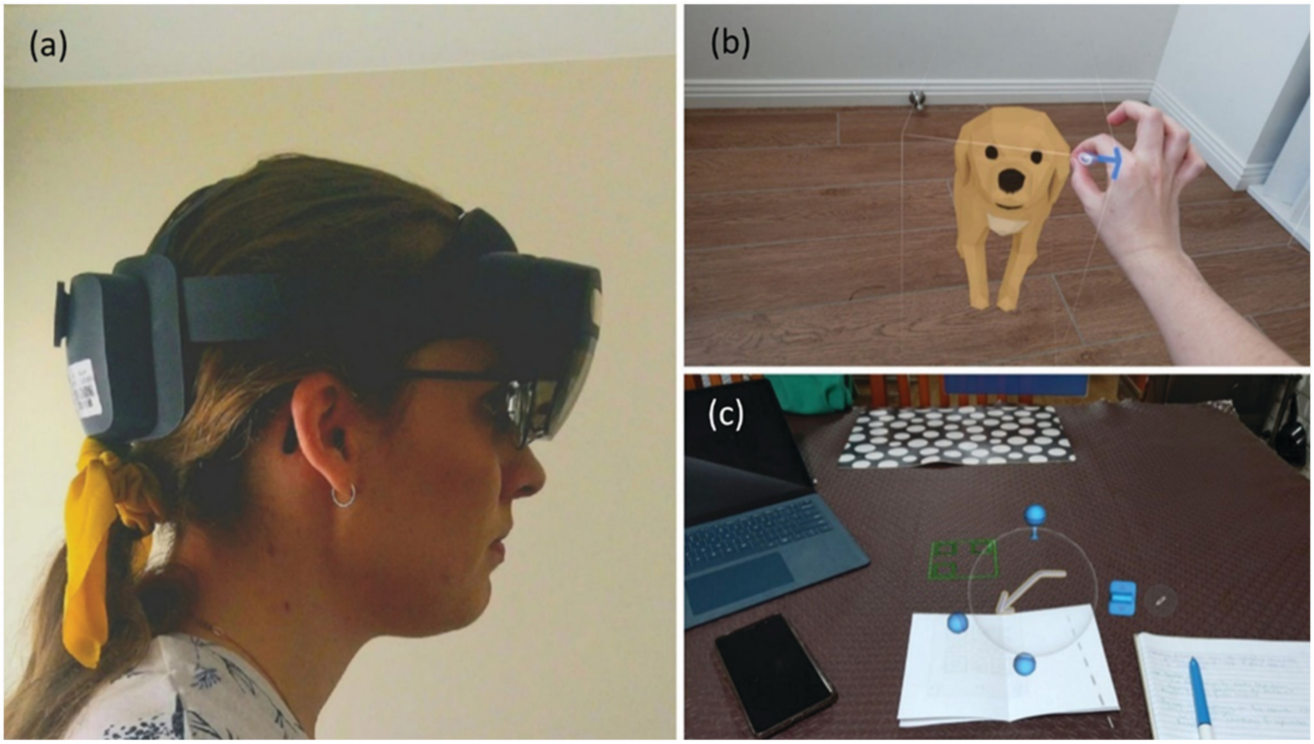

Figure 1. AR head-mounted Microsoft® HoloLens2®: (a) the device worn by the first author, (b) the first author's user view of an AR hologram in her home, and (c) the first author's user view of an AR "visual guide" (blue dots and arrow) to provide origami instruction.

Using an AR game with instructions presented on an iPhone screen, Kang and Chang [16] taught three teenagers with intellectual disability a procedural task of using a simulated Automatic Teller Machine (ATM). Practice and teaching the teenagers in a simulation yielded positive results, and all acquired skills for ATM use in the study. These results supported the findings of an earlier study utilising AR to provide navigational instructions to six college students with intellectual disability [17] in which the authors reported that AR was more effective, and preferred by participants, than other digital or paper-based navigational maps.

Immersive AR technology, using a headset and glasses to give the user the impression that the augmented display is part of the real world, is emergent, and there are few studies exploring use of the technology to support people with disability. Keshav et al. [18] and Liu et al. [19] both used the Google Glass® AR device (discontinued in 2015) to teach social skills to children, adolescents and adults with autism. In Liu et al. [19], The Empowered Brain system (formerly the Brain Power System) used AR visual supports with children and young people with ASD to direct users towards the faces of their conversational partner, to improve interpersonal interaction and emotional recognition. In the study, the researchers gamified interactions by awarding points for desired behaviour, with reported positive outcomes in the comprehension of emotion and body language. Keshav and colleagues [20] replicated those findings with a child with ASD in a classroom setting, reporting improved conversational engagement. Both Keshav et al. [20] and Liu et al. [19] reported improvements in participants' ability to establish and maintain eye contact, even while using the visual support system.

Recently, researchers investigated the feasibility of using AR with children and adults with neurodevelopmental disability. Following participatory co-design principles [21], parents of children with developmental language disorder, speech-language pathologists, a technologist, an orthoptist, and an occupational therapist working with children with developmental disorders were asked to generate new ideas on potential future applications, and barriers and facilitators to the use of AR with this group [22]. Participants identified several potentially useful purposes for AR visual supports. These purposes included supporting people to learn everyday procedural or adaptive tasks, such as packing a school bag, tying shoelaces, or making tea [22]. Participants considered that computer images overlaid on the physical world and viewed through AR glasses could provide unique written, pictorial, and video supports for people with disability. In addition, as in the prior use of a smart watch for remote prompts in Schlosser et al. [14], participants considered that visual supports could be delivered remotely, with users guiding the wearer of the AR device to engage more independently in more complex daily tasks, such as cooking and activities of daily living [22].

Current and future potential applications of AR in practice

AR technology, typically designed for commercial and industrial use, provides holographic instructions tethered to specific objects and locations and directs users to complete specific complex tasks, particularly in the manufacturing industry [23]. For example, Boeing utilised AR visual supports to provide instructions to technicians installing wiring in their aircraft. The situational visual guides reduced error rates and cut production time by 25% [24]. These advances in AR technology mean that, in time, future ASD and AAC professionals and educators could potentially learn to develop and program individualised, task-specific AR visual supports and AAC systems for children and adults with neurodevelopmental disability.

Potentially, the use of AR to support the user's visual receptive mode or visual instructional mode [3] could deliver visual instructions and guides integrated into the user's environment. However, immersive AR is an emergent technology in that: (a) it is relatively expensive and not widely available (compared to the ubiquitous mobile devices, smart phones and smart watches, and non-immersive AR using tablet devices), (b) there are few "off the shelf" software applications commercially available for use in practice or in research outside industrial settings, (c) it is not widely available to the home user, (d) there is little information available for users who have a low level of technological literacy or programming skill; and (e) immersive AR using headsets is as yet untested as a visual support to communication or procedural learning, or as an AAC system for children or adults with neurodevelopmental disability. Anecdotal reports suggest that AR could support people with disability to participate in the workforce [25], however there is little evidence yet that such applications would support functional and meaningful workforce participation. Thus, little is known about how an immersive AR technology, using a headset that projects visual supports onto the user's real world during activities, might be accepted or adopted by novice users, and the types of experiences or learning supports that may be needed to successfully use the device.

In order to evaluate the novice user experience and further appreciate the potential uses of immersive AR devices in the field of communication disability, the Microsoft® HoloLens2® device was selected. The HoloLens2® was the newest wearable AR device on the market at the time of this research, and so represented many of the newest advancements in the field. The aim of this duo-ethnography was to evaluate the usability of the Microsoft® HoloLens2® device and contribute to the participatory design literature to inform future research on AR in populations who need or use visual supports. Specifically, the authors, both speech-language pathologists and technologists, aimed to examine the user-experience in the process of: (a) using Microsoft® Dynamics 365 Guides® to author an AR visual support using the Microsoft® HoloLens2®, designing a visual support for a specific purpose (making a cup of tea), and (b) use the Microsoft® HoloLens2® with the AR guide developed to make a cup of tea. These immersive experiences were designed to stimulate the authors' own appreciation of the possibilities for using AR visual supports in future participatory co-design research with people with neurodevelopmental disability, as it would help to identify usability constraints and barriers to using the technology that should be addressed to enable its use by people with neurodevelopmental disability and their support teams. Considering the low availability of the Microsoft® HoloLens2® and most users of the device being within the industrial space for which the device was designed [26], users in the field of communication disability (i.e. people with disability, and their families and teachers) would likely need additional support and training to understand the hardware, software, and how the process of programming a visual support guide would work.

Method

Considering it posed no risk of harm to the researchers, this study was given an ethics waiver from the Human Research Ethics Committee at the University of Technology Sydney, Australia.

Autoethnography

Autoethnography is an approach that enables the researcher to appreciate and document their first-hand experience [27]. In this study, the method was selected to enable the researchers to capture elements of the novice experience in using the Microsoft® HoloLens2® that could inform and accelerate its use in the field of communication disability. Auto-ethnographic methods involve reflection and re-presentation (through rich description enabling content thematic and process analysis) [27], providing a vehicle for the authors to examine the process of creating, implementing, and using immersive AR visual supports for procedural tasks. While building, installing, and testing immersive AR guides, we took detailed audio memos, video recordings, and detailed notes to establish a record of our thoughts and experiences for further reflection and discussion. We reflected on those experiences and records to create a detailed, thick description of the experience for others who might undertake this process in the future [27]. Our narrative and reflexive methods tell the story of our process, and document our reflections on potential applications, implementation, and adaptations for future use of AR technology to provide integrated environmental visual supports for procedural tasks.

Process of data design, data collection, and data analysis

The method of designing and implementation of the AR visual support was completed in four steps. In Step 1, the first author took the role of *designer and developer* of an AR visual guide to making a cup of tea (using Microsoft® Dynamics 365 Guides® software) and first user and tester of the Guide developed. By design, the activity of "making a cup of tea" was selected from the focus group results [22] as a meaningful everyday activity, and one with which both authors were highly familiar, keeping the focus on the less familiar task of both developing the guide and testing it as a novice HoloLens2® user. In Step 2, the first author installed the AR visual support into the physical space of a kitchen at the University. In Step 3, the first author tested the AR visual support and made any changes to the design and placement that were needed. Finally, in Step 4, the second author took the role of novice user of the HoloLens2® and used the Guides® software to make a cup of tea. These user experiences were recorded within the HoloLens® software enabling both audio and visual data to be captured for review. The steps taken to develop and test the guide are illustrated in Figure 2.

Following the user testing, the researchers together reviewed the recording taken within the HoloLens2® of the experience and reflected on the affordances of the device, and any usability issues for a novice user along with implications for research including people with neurodevelopmental disability. These reflections were again recorded. The recordings were subject to content thematic analysis and process analysis [27] to determine key themes and experiences, reported in the results.

Prior experiences of AR and visual supports

As colleagues over the previous seven years, we had worked and collaborated in a VR and AR research group and had relatively recent access to a Microsoft® HoloLens2® device and the Microsoft® Dynamics 365 Guides® software and no prior experience with the earlier HoloLens®. Together, we had more than 40 years of speech-language pathology experience in clinical and research practice including people with communication or swallowing disability, and their health and safety in healthcare settings or at home. Our prior experiences as speech-language pathologists and communication technologists informed our views on the potential uses and applications of immersive AR technology as a visual support system. We have both used visual supports and AAC systems in clinical work with children and adults with communication disability, using both low and mobile technology for visual schedules, instructions with visual components, and AAC systems to support organisation, comprehension, expression, and engagement in a wide range of activities.

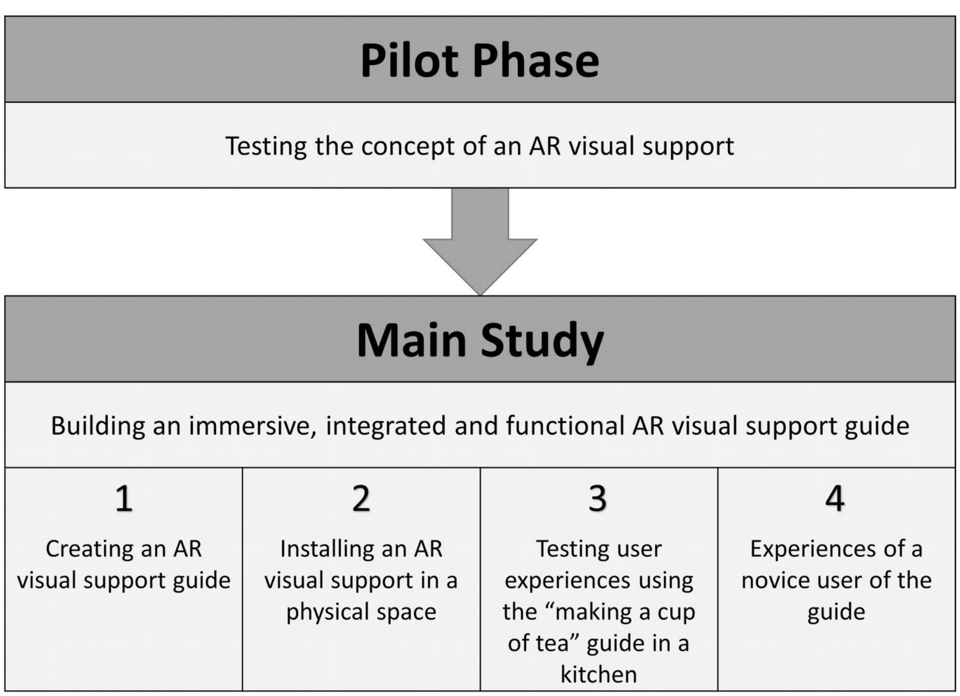

Figure 2. Methodological process of designing, building and testing an AR visual support.

The proposal for using the Microsoft® HoloLens2® immersive AR for delivering visual supports was highlighted in a multidisciplinary discussion (including speech pathologists, an orthoptist, occupational therapist, and AR design specialist) about the potential for AR as a tool to support language learning for children and adolescents with communication disability [22]. We considered that the idea of overlaying detailed digital imagery to support someone through the completion of complex tasks might be feasible with the right AR device and software. Once we had identified an existing application for this purpose in Microsoft® Dynamics 365 Guides® for Microsoft® HoloLens2® (see Figure 1(a)), we were encouraged in the view that providing visual supports was a possibility using this platform.

Microsoft® Dynamics 365 Guides® is an immersive AR application designed to "create step-by-step holographic instructions to use where the work happens" [28]. Guides® uses instructional step cards, symbols to mark focus areas and actions, and media (i.e. photographs, images, or videos) to provide visual support. Instructions are anchored to the environment using a trigger image or QR code, and users transition between steps using triggers including voice, eye gaze, or by pressing a holographic button.

We approached the authoring and testing of a visual guide using the Microsoft® HoloLens2® as *informed novices*, still relatively new to AR and the device and its software, but not without expertise. As informed novices, we had seen and used the technology for basic functions. We had played with simple, in-built apps meant to highlight the features of the device; however, we had not experienced any significant functional use of the system in clinical or real-world settings. Our familiarity with the technology was likely to give us some advantage over other novice users faced with the challenge of creating an immersive AR support for a person with disability. Our investigations prior to conducting this research suggested that authoring a visual guide would not require coding skills but would require some familiarity with word and image processing. The first author therefore possessed sufficient technological skill to create a Guide®.

While completing the research reported here, we were also investigating AR and its potential as a visual support, and had growing experience in the use of AR. We were also developing an immersive AR application (to teach prepositions and verbs to children with autism) with partners and collaborators utilising this technology [22,29]. This experience gave us perspective on the capabilities of AR, as well as some knowledge of potential barriers we needed to overcome.

Results

Pilot phase: testing the concept of an AR visual support

As a first attempt at authoring a visual support guide, the first author selected a simple origami task of folding a paper hat to create a guide to follow in AR while wearing the Microsoft® HoloLens2®. This particular task required few resources and could be easily completed in any environment with a table and a piece of paper. This task was designed as a pilot to test the steps required to develop and install a guide into the Microsoft® HoloLens2®, prior to attempting the guide development and installation with a more complex procedural task (making a cup of tea).

Steps in development

The first stage of the development process took place in the desktop design environment. The desktop application was used to create the anchor and instructional steps (see Figure 3). The individual step cards provided the platform to attach symbols and media to each step (see Figure 4). It was clear that significant planning would be needed for each step prior to the build, to

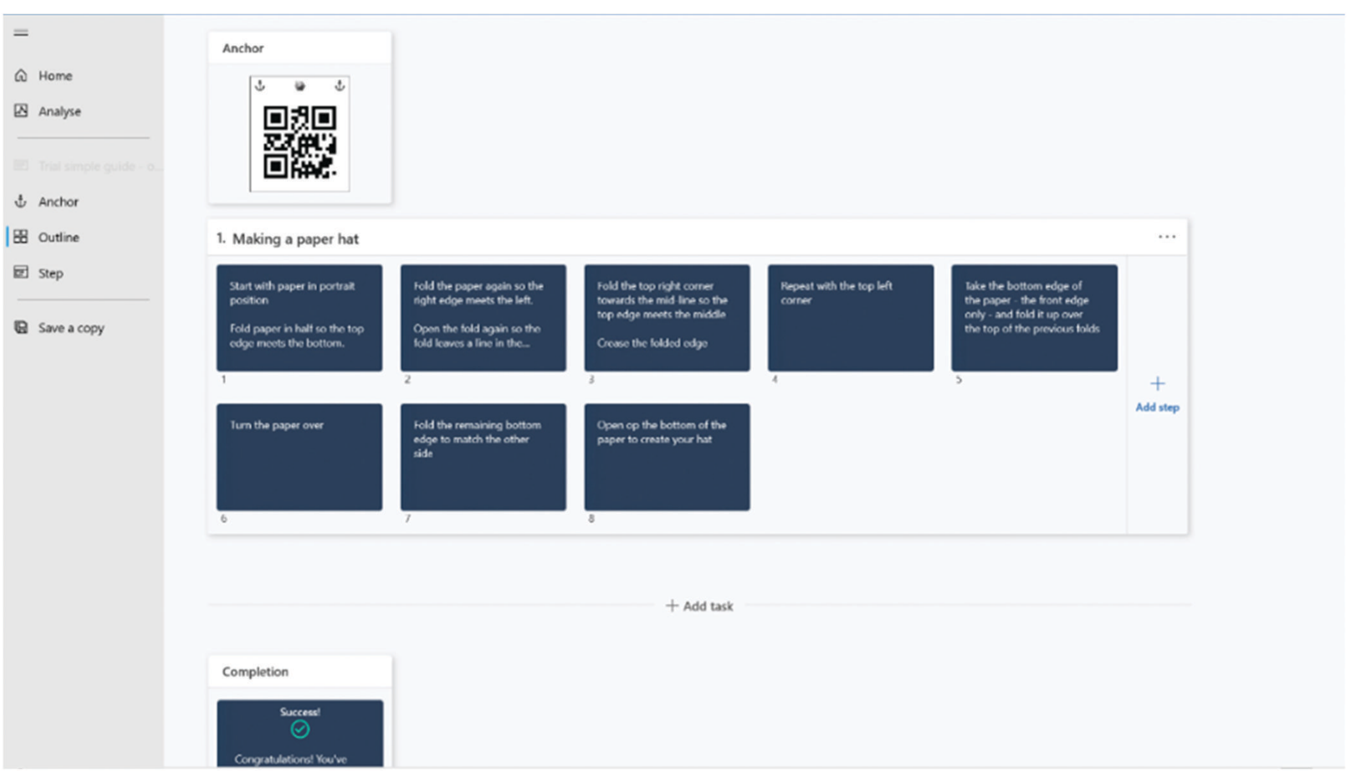

Figure 3. Desktop environment for the creation of the Guide.

identify the necessary symbols and media that would provide the user with enough detail to follow the procedure. The first author approached this task in a systematic way: by writing out the steps, planning the symbols (i.e. arrows, ticks, crosses, target zones, etc.), and identifying the media needed to attach to each step. However, it was still quite overwhelming. The how-to resources available in using the Microsoft® Dynamics 365 Guides® software suggested the process was easy and required no coding experience [30], but the technological skills required were in fact quite high. Actually attempting to use the software to create a guide to folding an Origami shape made it clear that substantial effort would be required to establish the foundation of an immersive and situational instruction Guide for a complex task.

The media creation was the most notable challenge to usability and the user experience. Should it use videos or images? How would these be created? The first author undertaking this task during the Australian COVID-19 lockdown of 2020, needed a second pair of hands (a family member) to be an assistant and photographer. A second person made the process much more straightforward. The procedure involved the first author creating the origami hat while the photographer captured the entire process. The first author then had to sort through the images to select those that best represented the required action associated with each step in making the Origami shape and upload them to the Guide. The challenge of media creation made it clear that either advanced media skills (using photography and recording equipment) or both an *actor* (on the objects) and a *captor* (digital photographer) are needed to create a Guide. This could make Guides creation a challenge for an AAC clinician, teacher, parent, or support worker to build a Guide for a person who needs visual supports for communication or learning. Collaboration over the process would be required in order to build a Guide that reflected both the steps and the visual media needed to prompt the user at each step in the process.

Installation of the visual support

Once the Origami guide was developed on the desktop application, it was installed into the HoloLens 2®. Far from being a swift or easy process, it required the first author to again work through the step-by-step process, attaching the symbols and graphics or videos assigned to each step to the physical environment, to the paper being folded in the real world to create the origami. As each symbol was selected, it appeared as a hologram overlaid on the first author's environment that could be grasped, twisted, and turned in the hand, and put down on the paper where needed. The symbol placement was attached to an *anchor* in the software (a QR code), so they would remain in place relative to the anchor when guiding other users in folding the Origami shape. A QR code was selected for simplicity and as the default option in the device that other novice users might be more likely to select. The software also provides an advanced option for anchoring to a digital model or hologram for objects in the environment. This mode of anchor would require the creation of that model or hologram, which was too complex for the first author given their novice level of programming skill. The first author printed the QR code on the origami paper to simplify the anchoring process and to ensure that the origami paper would always be oriented clearly to the installed symbols. This demonstrated that a QR code in an environment for a situational guide would need to be fixed, as moving the anchor would move all of the symbols that were placed.

User testing the visual support

The first author tested the Origami Guide a few times, running through the process from start to finish to make sure the symbols were placed correctly, and the instructions made sense. Using this process, several successful Origami hats were created. The first author noted:

> Since the anchor was printed on the origami paper, I tried moving to different locations and testing the Guide in different rooms of the house. The instruction cards, media, and symbols all remained oriented to the anchor and so the Guide continued to function effectively as I moved. The written instructions and symbols worked well, although I had some concerns about the media. The media was attached to the left side of instruction card (as per the user's view). The image was useful, but they didn't depict the action very effectively. (First author)

Being familiar with the procedure, she could comprehend the images. However, she also:

> Wondered if those images would be effective and meaningful to a user with disability needing visual support. An image did not fully and clearly represent the procedure that a user of the Guide would need to follow, and a video may have been better. (First author)

With these lessons learned from this first attempt, the first author moved on to creating and installing the "making a cup of tea" Guide, one designed to be more complex and potentially more meaningful and usable in building independence in a daily task for a person with communication disability.

Main study: building an immersive, integrated, and functional AR visual support guide

Our second attempt at creating a visual support had a much more functional focus. A simple task such as making a cup of tea is something we do every day with little thought as to the process. However, breaking that down highlighted the number of individual steps required to achieve success. The environment was also an important factor in this guide, requiring a kitchen setting and the acknowledgement of hazards within that environment such as knives in a cutlery drawer and boiling water from a kettle. A simulation teaching room, a kitchen, at the University of Technology Sydney, Austraia was used for this purpose.

Creating an AR visual support guide

The first author commenced the authorship process by creating the anchor, a QR code that was placed in a kitchen environment. This anchor is required for the HoloLens 2® system to orientate AR projections to the real world environment (e.g. to line up the AR graphics with the real world environment on which the visual cues are going to appear). Learning from the first creation of the Origami guide, an anchor for this type of Guide was needed to make sure the environmental cues, arrows and markers were correctly placed to enable successful use of the Guide throughout the activity of making tea. She laminated the anchor and secured it in location on the wall behind the kitchen bench. While this placement of the anchor may have obscured its visibility, a picture cue was built into the guide to show the user where to locate it and start the guide. The author selected the wall as the location of the anchor as directed by the software – choosing an immovable location to which the rest of the holographic Guide could be anchored, and therefore preventing movement of holograms from their required position. Reflecting on the anchor, the author noted:

> it was quite ambiguous. If a person required more than one Guide in their environment, there would need to be a clear, pictorial cue alongside the QR code so the user could easily identify the anchor

associated with each Guide and activate the Guide that they needed at the time they needed it. (First author)

With the anchor created and placed, the task needed to be segmented into a number of distinct steps (see Appendix 1), each containing one or two clear actions (e.g. moving, placing, or using objects). She noted:

> My approach was based on the idea that instructions simplified for those with the most basic level of language comprehension ability would be accessible to any user. While the text-based instruction cards formed the centre point of each step in the visual guide, I also wanted to ensure that each step could be clearly illustrated with visuals, including arrows and environmental markers (e.g., a symbol indicating which cupboard to open). (First author)

Accordingly, the arrows and markers were selected from an existing library within the application and assigned to each step in desktop application. This ensured those visuals were available to place within the environment when the Microsoft® HoloLens2® was being used to install the guide that had been developed.

The text instructions and symbols alone would form a strong foundation for a visual support; however the addition of visual media would increase the accessibility for users with communication disability. While the Guides application allows the author to import media (photos or videos) to align with each step, once again the media needed to be created before it could be attached to the Guide. The first author reflected upon this:

> A challenge arose as I considered how to take videos and photos depicting the actions in each step without a second person – one person to film and photograph (captor) while a second person completed the task (actor). In the initial trial of a Guide, I had that second person to assist. This time I was alone, although I considered that this was probably a challenge that a lot of support workers or therapists would face if they were building Guides for their clients. I considered a tripod and determined it would work for some steps but not all. I also wanted to use videos rather than images because of the lessons learned from the first trial. Thinking ahead, I knew it would be easier to create individual videos (using one hand while with the other I completed the activity) of each step - rather than one video of the entire procedure. (First author)

This eliminated the step of editing a long *third party* video at a later point to create media for each step in the "making a cup of tea" guide. The first author recorded video examples by hand (i.e. not using a tripod) from her own perspective, rather than from the perspective of a third person observer. She considered that "such videos might actually be useful since the user would see in the guide exactly where to reach and what action to perform in their environment" and determined that later user testing would reflect whether the perspective of media needed to be more carefully considered in the creation of a visual support guide.

Attaching the media (photos and video cues) appeared to be a straightforward process. Each step was recorded as a separate short video or picture file that could be uploaded to each step of the Guide. She noted that "in order to identify each piece of media clearly, I labelled it to indicate the step with which it corresponded (i.e. one to 14)." Uploading images to the desktop Guides environment was by now a relatively familiar and simple process, with parallels to uploading an email attachment. Once the media existed in the build environment, adding each piece of media to the corresponding step was a process of dragging and dropping the relevant file to the media panel within each step, a panel clearly labelled for this purpose. The first author reflected:

> It was here that labelling the images with the step number was vital so I could clearly identify which piece of media I needed to add at which time. I didn't do this on my first attempt at building the Origami Guide, which is perhaps why some training is needed before implementing a Guides building process. It certainly simplified the build process. (First author)

This process concluded the build in the desktop app and the first author moved to installing the Guide using the Microsoft® HoloLens2®.This step involved situating the visual support guide within the physical space where it would be used – a kitchen. The media created had been filmed within the same kitchen where the Guide would be installed and used. At this point, though, the first author wondered if the same desktop Guide pieces could be installed in any kitchen:

> If the media were generic enough, a new anchor in any kitchen could facilitate the installation of the same instruction cards and symbols for the same procedural task. This would remove a significant part of the Guide development process and possibly assist in implementation. One person could create all the media, write the instruction cards, and assign the symbols. Any person could then draw a Guide from an existing library and place it in their own environment. This could simplify immersive AR Guides and make the technology more accessible to users. (First author)

Installing an AR visual support in a physical space

With the guide now constructed in the desktop environment, the next step was installation using the Microsoft® HoloLens2®. After overcoming some cursory technical difficulties by updating the Guides application on the headset, the first author opened the program. Two options were available: (1) Author – where all of the AR visuals are placed within the Guide to install it in the space, and (2) User – who can see the visual support but is unable to edit them. For the installation process, the author option was selected. The step-cards (i.e. the written instructions for each step), media and symbols selected in the desktop environment were now visible. The first author noted:

> Wearing the HoloLens2®, I placed the virtual step card on the kitchen bench. At this point I moved around the kitchen space to make sure that the virtual card was visible as I moved from the sink to the fridge, and that it did not obstruct vision at any point. By grasping the virtual step card, I could move it further back so it sat clearly on the bench and could be easily referenced throughout the task" (see Figure 5). (First author)

The visual media prompting each step in the "making a cup of tea" sequence was *tethered* to the left of the step card and could not be moved. This meant that the primary factor in the installation process was the placement and orientation of directive symbols and the step card.

For each step, the first author activated a symbol by touching it in the grid below each step card. This grid was presented in the AR environment much like it had in the desktop environment (see Figures 3 and 4) and can be seen below the step card in Figure 5. She noted:

> I discovered that I could select a symbol multiple times and add it to the environment in several different locations, for example to create a trail of arrows to a destination. This meant that I didn't need to get caught up in overthinking how *many* symbols I needed at the desktop creation phase. Instead, I only needed to consider the *types* of symbols I would need. (First author)

The depth placement of symbols was one of the main issues faced when installing the Guide in the actual kitchen. Symbols needed to sit on surfaces, for example on the door of a cupboard, but not below the surface or above the surface. If symbols did not sit flush with benchtops, cupboards, or objects, they appeared to be slightly misplaced as the viewer moved around the kitchen. This is apparent in Figure 6 , where the far left arrow does not appear like the others in the centre of the cupboard door from a lateral viewing angle.

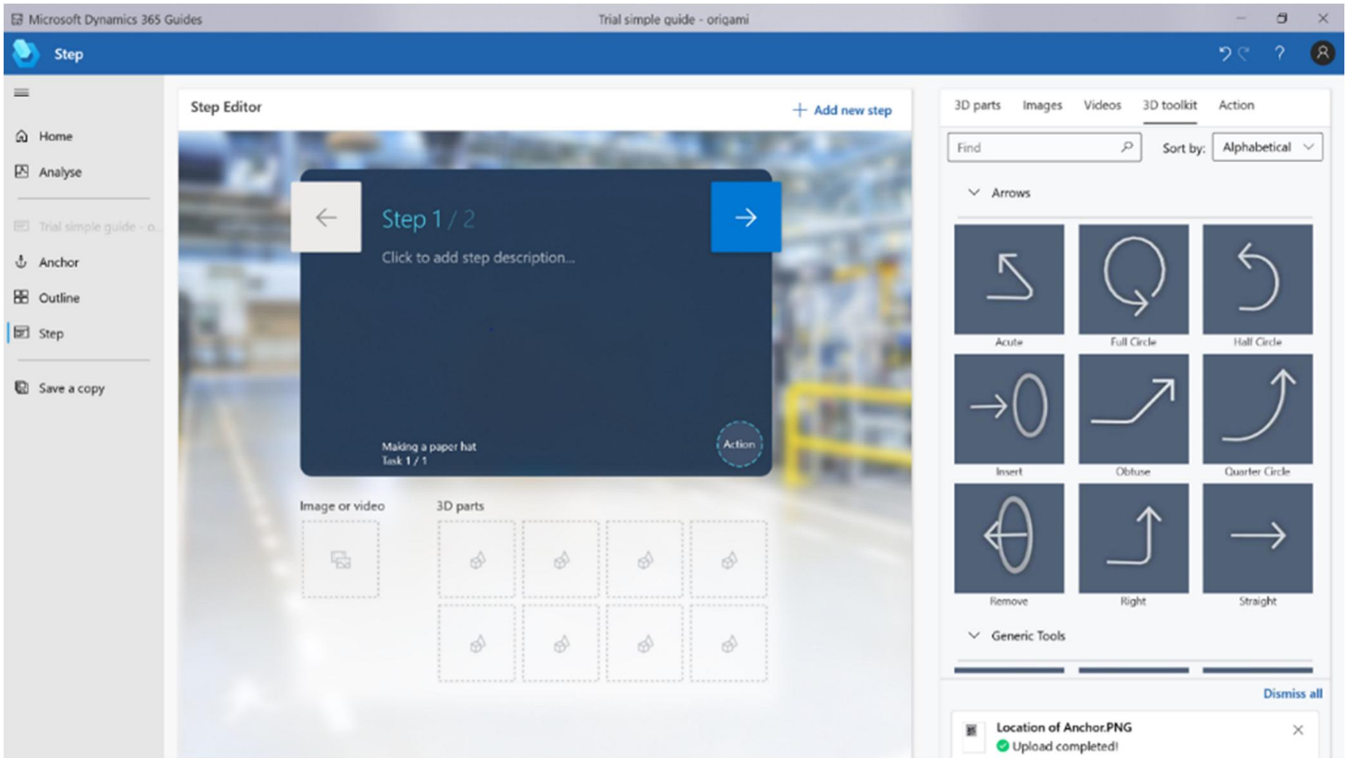

Figure 4. Desktop environment for the creation of the individual steps.

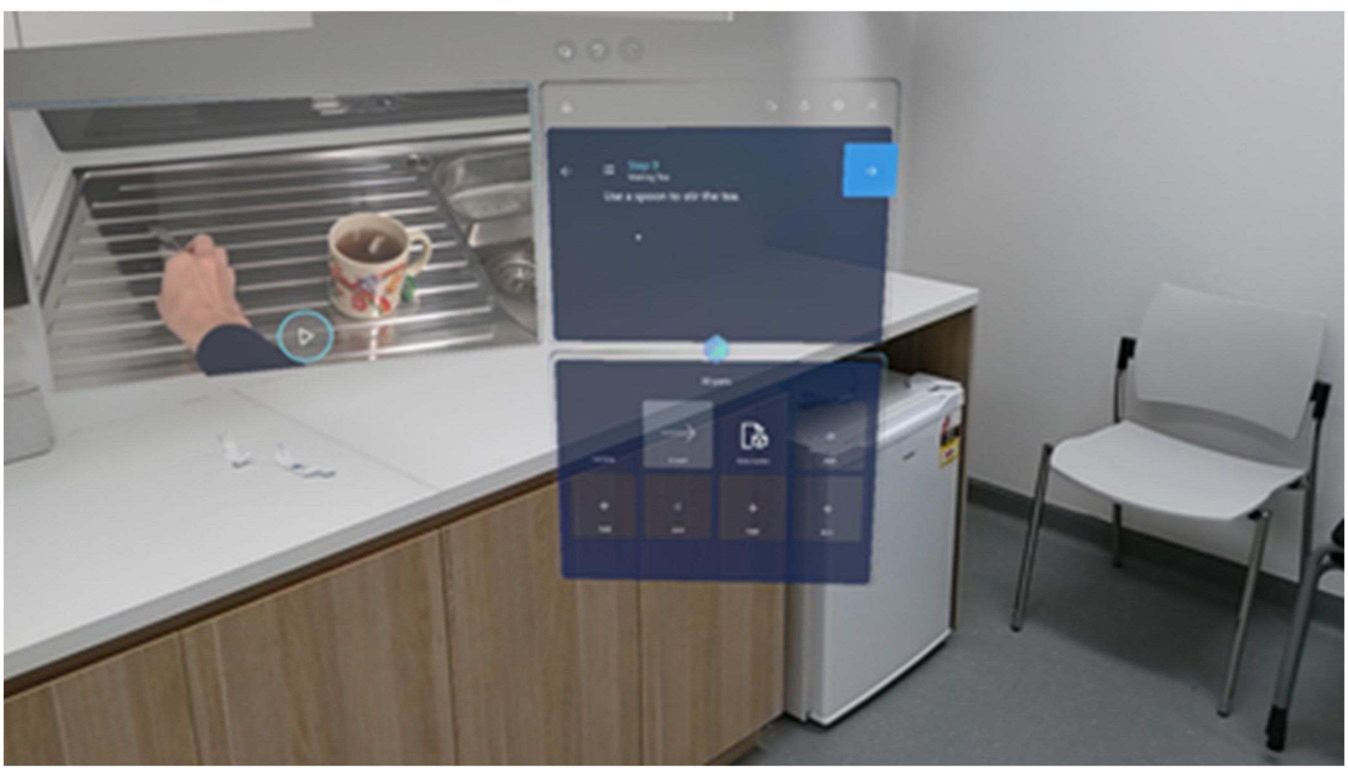

Figure 5. Placement of the step-card and its tethered visual media in the kitchen environment.

Appropriate sizing, orientation and positioning of symbols therefore required some advanced programming skills. These elements were adjusted using a number of virtual *switches* around the symbol when it was selected in the environment (see Figure 7 – these switches are the blue dots visible around the symbol). By pinching or grasping those switches, the symbol could be resized or rotated. However, the first author noted:

> "This was not always a straightforward process and I regularly found myself over-rotating or over-adjusting the size. I needed a lot of patience and fine motor precision to successfully complete this task. I

> could then grasp and place the symbol just by holding it in a fist and moving it. I also discovered an "edit" menu associated with each symbol (evident as the grey dot with a pencil symbol on the right in Figure 7, beside the sizing switch). Using this menu, I could delete an unnecessary symbol, or duplicate an already sized and oriented symbol if I needed more than one. This meant that I could have multiple symbols of equal size, creating a Guide that was more aesthetically appealing. At this point I also switched back and forwards between the many steps in the "making a cup of tea" procedure multiple times to confirm that the symbols remained where I had placed them. While the Guides app is clear that symbols are tethered to the QR code, I needed to confirm this for my own peace of mind and was relieved to find that all the symbols remained where I placed them. (First author)

Testing user experiences using the "making a cup of tea" guide in a kitchen

With the Guide installed, the first author switched to the user option to test its use in the kitchen. She noted:

> My initial use of the Guide illustrated some problems straight away. Some of the symbols were not positioned in a way that clearly directed the action. I found myself switching between the user and author platforms multiple times to adjust the position of symbols and refine the Guide. (First author)

This really showed that testing and refining the authorship in multiple steps is necessary in the design process and development of the Guide. The first author reflected:

> Overall though, I was impressed. When I took a cup from the cupboard and placed it in the target zone on the sink, the action symbol directing me to stir in the sugar was perfectly placed over the rim of the cup. Step-by-step, I was able to complete every action in the "making a cup of tea" procedure with clear direction. I was struck by the thought that the same Guide and symbols would be transferrable to any kitchen (as long as it had the same facilities – e.g., cupboards, cups, sink, spoon, instant hot water tap). (First author)

When repeating the testing stage, the first author noted:

> It was evident that the equipment needed for the task would need to be positioned in the same way it was when the Guide was installed. For this particular Guide, this meant that the cup, tea, sugar, and milk needed to be in the same location in the kitchen, with the same positioning and orientation as at the installation. Where positioning of these objects did not correspond with their place as at the initial installation, the AR instruction prompts including targets and arrows no longer lined up with the objects to which they were meant to direct the user. When I went to retrieve the cup from the cupboard where I had placed it, the hand/action symbol I had placed for this step no longer aligned with the cup. Instead, it was slightly to the side. (First author)

To overcome this problem, she implemented a simple solution, drawing the outline of the cup, tea, and sugar on to coloured pieces of paper and affixing these within the cupboards in the kitchen to create placement markers. Following the completion of the guide, she returned these objects back to the same position as indicated by the placement markers, ensuring that when the guide was trialled again all AR supports accurately indicated their referents. Although this seemed relatively straightforward, it may not be practical in a busy kitchen used by a number of people (e.g. in supported accommodation for people with disability).

Experiences of a novice user of the guide. In this phase of the study, the second author repeated the trial and commented on the experience of using the Guide to make a cup of tea, the AR visual support installed in the kitchen space. As expected, she needed some verbal cues from the first author on opening the app while wearing the Hololens2®, on what buttons to press and how to navigate from one step to the next. This indicated that any novice user of new technology is likely to need similar prompts and cues when first wearing the device. In this "training" phase, a screen-mirroring application was used, as through this process the first author could use her laptop to view the AR world that the second author could see while wearing the device. As such, the first author could easily direct the second author to target areas to touch and interact. The second author did require more training and instruction to move between steps in the procedure (i.e. the steps outlined in Appendix 1) including verbal prompts and cues. In making transitions between the action steps on each instruction card in the procedure, a user can press the arrow button, say "next step" or gaze at the arrow button for approximately 3 seconds. The second author quickly showed a preference for gaze-based transition, though often averted her gaze before the step transitioned. She remarked "I keep moving away too quickly" and required reminders to await audio cues to signal transition before looking away. This has implications for use of the device by people with neurodevelopmental disability, who would need to be able to attend to both auditory and visual information, and also learn to use 'watchful waiting' for cues and guiding prompts to use the system successfully.

The first author noted:

> As the second author progressed through the steps, I realised I may have broken them down too far and created too many small steps for single action sequences. For example, step 1 of "open the cupboard" and step 2 "take a cup" increased the demands on the user. (First author)

Similar breakdown was evident between steps 3 and 4, and steps 10 and 11 (see Appendix 1). When the second author opened the cupboard, she intuitively retrieved the cup straight away, already (by knowing the task) knowing the action that was likely to follow without viewing the next step. The second author reflected "Perhaps the act of looking away from the focal point of the cupboard and back to the step card was too much." This did bring to light another issue though, and that was in the positioning of holographic symbols to provide direction. When steps were not progressed, holograms remained in the way of the next action. This was particularly apparent when the marker indicating which cupboard door to open obstructed the view of cupboard contents, as in Figure 8. The second author remarked "I found this positioning of holographic symbols distracting and unpleasant. Like when I was stirring tea, when the symbol appeared on the rim of the cup, I had to reach through the symbol to stir my tea." She also stated that she found that such symbols "interrupted my spatial perception" and that they were "a bit disorienting for me". She identified a preference for a symbol to be behind or under an object to touch, and particularly remarked at the value of symbols that were positioned in this way. The first author noted that "I didn't have the same experience". The differences in user opinion demonstrate that people may have unique preferences in how a guide is presented and installed, and that this individualisation or customisation in design will need to be taken into account in each user's unique environment.

Target zone symbols appeared throughout the Guide, telling the user where to place an object they had retrieved. The first author reflected that "When I installed them, I did not consider they would be ignored, however the second author often placed objects outside of target drop zones. As a results, the symbols in proceeding steps did not align with objects appropriately." This may have been due to familiarity with the "making tea" procedure, and again may need to be considered in Guide development, in that too much detail in a Guide may be detrimental to its successful use if some procedures are intuitive or familiar through prior exposure. It might be difficult to balance the number of cues provided or required in the system, with the user ultimately learning the sequence independently.

Figure 6. Placement of symbols in the installation environment.

Figure 7. A symbol in the Guide installation environment with switches (blue dots and rectangle) to size and orient.

Discussion

Reflecting on implementation to support people with disability

Our experiences designing, building, installing, and testing an immersive AR visual support guide for HoloLens2® for a functional activity of daily living, and teaching another person to use it, confirms the finding of prior pilot research that AR technology could provide valuable support for people with disability [22]. Overall, the results of this research support and extend the finding of prior AR research beyond its use as feedback tool [18–20] and

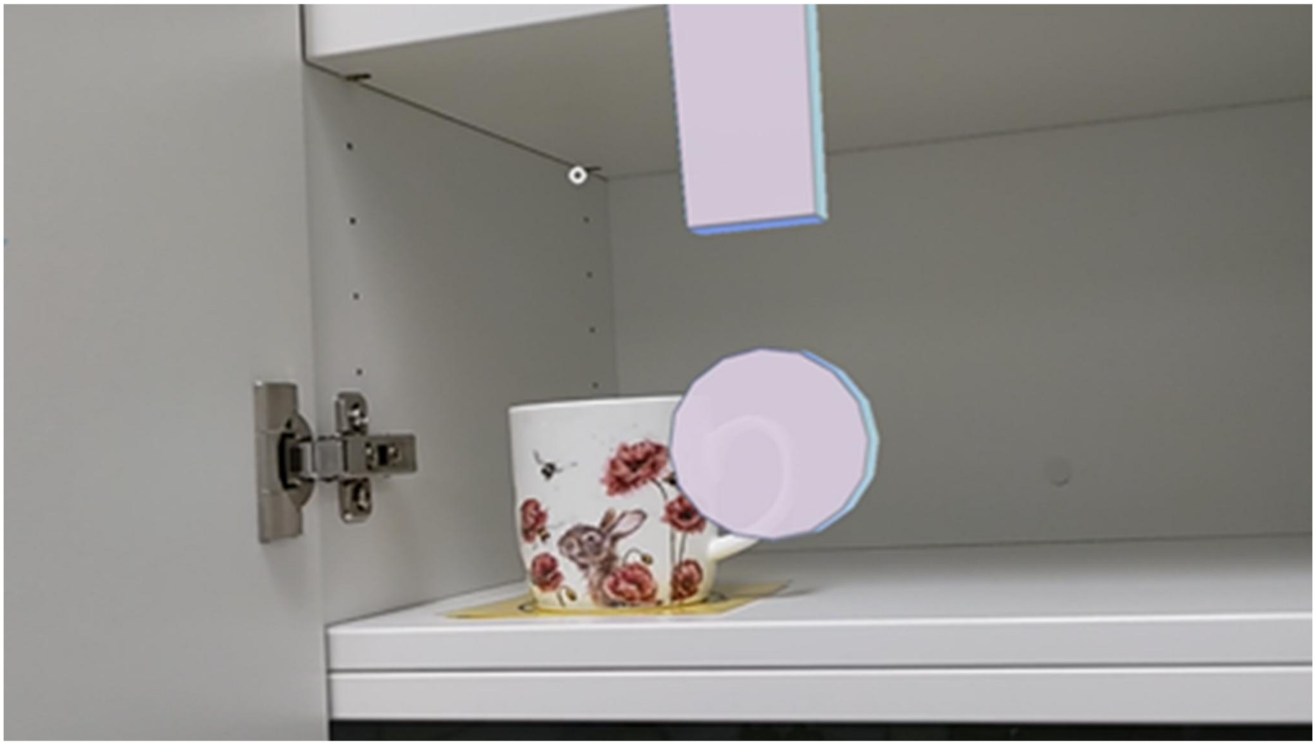

Figure 8. The overlay of holographic symbols disrupts the user view of objects.

into its use in the instructional mode of visual immersion [3]. The Guides® software aligned with what Shane et al. [3] defined as the visual instruction mode of visual language, and with the structured visuals that Zimmerman et al. [12] identified within classrooms, used to support children with neurodevelopmental disorders to engage in an activity while in progress. Using the AR Guides® software provided researchers with a stimulus for actively engaging with the visual supports in the environment during a familiar activity, enabling the active participation that is often lacking when visual supports do not integrate with the environment [1,11]. This active engagement with environmentally integrated visual supports could enhance the consistency of task performance, engagement and independence already reported in the visual support literature [7,12]. Indeed, reports from industry support this assertion and show increased consistency in task performance with integrated AR visual instruction [24]. Thus, the use of AR Guides® applications could be helpful for increasing independence in children with disabilities, including autism, who require visual supports for learning sequences in activities [6,8,9].

However, the Guides® software used in this research may not be as suitable in supporting the visual expression mode of visual language [3] or interaction directly with communication partners. While some elements of the Guides® system integrated with the environment to foster active engagement, the placement of instruction cards drew attention back to a central spot and away from the activity at hand. In a conversational interaction, this division of attention could create a more passive interaction [1,11]. If AR were to focus on mode of visual language beyond instruction, further development of AR technology and integration of visuals through other applications and software would be necessary. This has been achieved in prior studies [19,20], so is not beyond the realm of possibility for this technology.

Our use of AR as a visual instruction tool could also inform how social enterprises seeking to employ and train people with disability in the open employment workforce might utilise technology to further grow the success of low-tech visual supports to support workforce participation [8,9]. Moving the established use of AR and Guides® in the manufacturing industry [23,24] into programs designed to increase the inclusion of people with disability in open employment [25] will require co-design of Guides® to include the intended users [21]. We are aware that the cost of AR devices such as the Microsoft® HoloLens2® (retailing for $3,500 USD from Microsoft) may at present be prohibitive and limit access to the technology and its affordances for learning sequential tasks. Just as other AAC technologies can be accessed through support services and funding, AR devices and applications could be justified with further research as to usability and benefit.

The Microsoft® Dynamics 365 Guides® program was reasonably straightforward to use for the app development, and we were able to successfully build and test a guide with no programming experience. As noted by Donato et al. [11] the success of visual supports relies to some degree on device-related factors. Our experiences reflected that the level of computer skill and exposure to AR would potentially be within reach of a teacher or parent supporting people who need or use AAC or visual supports for following instructions [11]. Although the installation process required a lot of thought, trial, and error, it was not difficult to manage or onerous in terms of the resources or time needed for success. However, the several usability issues highlighted in this study (e.g. the hologram guide items appearing over objects) need to be considered in further research and development for software applications using the HoloLens 2®.

Installing the Guide in a kitchen space sparked inspiration for all manner of possible ideas for other Guides that could be useful to support independent activities of daily living: operating a washing machine, tying shoelaces, packing a school bag, making a meal, or making a bed. Further, the similarity in the steps for creating a Guide, regardless of location, suggests that an AAC clinician, parent, or educator could create a library of Guides that users could draw from and install in a wide range of spaces for clients. This would reduce the time and resource demands that are associated with building a Guide, allowing users to skip straight to the installation process.

Limitations and directions for future research

This autoethnography was a first step in understanding AR Guides technology in terms of its potential as a visual support system for people with disability, and the complexities of the process involved in establishing AR visual supports. While limited to researchers without disability, the insights and knowledge gained from this experience showed what two relative novice users with limited experience of this technology could do with the technology. The findings of this research also show how AR guides might assist in the completion of procedural tasks in future research inclusive of individuals with disability, and how the system may be implemented in research in a manner that enables equal participation and informed consent amongst participants. The next steps in this research will provide demonstrations of the technology to, and trials of the technology with, people with disability and their supporters, including family members, support workers, and allied health professionals to ask their thoughts and opinions. Their experiences and attitudes towards using the technology will be instrumental in directing future applications and determining whether AR visual supports will be used as a tool to encourage and support independence in life, leisure, and work for people with disability. In order to appropriately co-design AR guides, the perspectives of these end-users will be instrumental. Their lived experience of disability will highlight opportunities and barriers that were not apparent to the authors of this research that will need to be investigated further.

The use of a procedural task that was familiar to both authors in this research enabled the comprehensive testing of the guide development process. However, it did impact on the testing phase. The first author developed the guide with a mindset of providing procedural instruction to an unfamiliar person – someone who was not aware of the procedure of "making a cup of tea" and would therefore need simple instructions. However, the second author was familiar with this procedure having done it independently many times, and therefore did not rely on the instructions or holographs to support each step of the process. An individual using an AR guide to complete a task with which they were unfamiliar would be likely to rely more heavily on the instructions and could therefore provide an opinion on the components of the guide (written instruction, holographic symbols, or photo or video media) that were most effective to support task completion. As a next step, the authors will be developing and testing guides for procedures to trial with unfamiliar actions; for example, folding a novel origami shape. In such a case, the research participant would need to follow the guide more carefully to reach the end point and may provide more comprehensive insights into the value of AR guide features in learning a procedural task.

The fact that the second author did not use the guide as the first author intended highlights a need for participatory design in the development of future guides. End-users (i.e. people with disability and their support workers) will be integral in designing guides that meet the needs of end-users, and function in a way that is appropriate to their needs and preferences. Future research will need to carefully consult with people with disability using participatory design methods [21] to determine the wants and needs and gain the feedback of the people who will use the guides to ensure they are fit for purpose.

Conclusion

Emerging immersive AR technology provides new opportunities to create integrated visual supports that function within the user's environment to enable active participation in activities and interactions. By overlaying typical supports within the user's environment, people with disabilities may be better supported to actively engage and attend to objects and to their communication partners when using AR visual support systems. However, AR technology is largely untested for this purpose. This study provided the initial steps in understanding opportunities and barriers to the adoption and use of AR by novice users, and the types of experiences or learning supports that may be needed to successfully use the device. The authors successfully created a visual AR guide for the procedural task of "making a cup of tea" and installed the guide in a physical kitchen space with very little programming knowledge. Testing of the guide highlighted differences in user preferences for the positioning of visual holographic instructions that necessitate a need to carefully consult the end-user of the guide in the development phase. For end-users with neurodevelopmental disability, participation in the development phase may be limited to observing their trials of other software apps and making design decisions based on their apparent preferences and response to cues for looking or listening to the HoloLens2®. However, the installation process also showed that a single author could develop a number of basic guides that could be installed in a range of different environments for different users, perhaps enabling easier use of this technology in the future. In moving to device trials for individuals with neurodevelopmental disability, either in clinical or research settings, it will be important for a user familiar with the HoloLens2® and software to be present to give instruction and support use.

The results of this study provide a foundation for further testing and evaluation of AR visual support technology. The experiences of two speech-language pathologists with novice-level AR experience, but a higher level of technological literacy allowed exploration of this technology. To properly understand the opportunities and barriers to the use of AR guides by people with disability, future research will consult people with disability and their support workers. Their personal experiences and insights will determine if and how AR visual supports may be used into the future to support participation in independent activities.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research was funded by a University of Technology Sydney Early Career Researcher Capability Development Grant awarded to the first author under the supervision of the second author, from the University of Technology Sydney, NSW Australia.

ORCID

Lucy Bryant http://orcid.org/0000-0001-8497-7406
Bronwyn Hemsley http://orcid.org/0000-0002-6255-3140

References

[1] Light J, McNaughton D, Caron J. New and emerging AAC technology supports for children with complex communication needs and their communication partners: state of the science and future research directions. Augment Altern Commun. 2019;35(1):26–41.

[2] Schreibman L, Dawson G, Stahmer AC, et al. Naturalistic developmental behavioral interventions: empirically validated treatments for autism spectrum disorder. J Autism Dev Disord. 2015;45(8):2411–2428.

[3] Shane HC, Laubscher E, Schlosser RW, et al. Enhancing communication for individuals with autism: a guide to the visual immersion system™. Baltimore (MD): Paul H. Brookes; 2015.

[4] American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Arlington (VA): American Psychiatric Publishing; 2013.

[5] Arthur-Kelly M, Sigafoos J, Green V, et al. Issues in the use of visual supports to promote communication in individuals with autism spectrum disorder. Disabil Rehabil. 2009; 31(18):1474–1486.

[6] Rao SM, Gagie B. Learning through seeing and doing: visual supports for children with autism. Teach Exceptional Child. 2006;38(6):26–33.

[7] Rutherford M, Baxter J, Grayson Z, et al. Visual supports at home and in the community for individuals with autism spectrum disorders: a scoping review. Autism. 2020;24(2): 447–469.

[8] Carson KD, Gast DL, Ayres K. Effects of a photo activity schedule book on independent task changes by students with intellectial disabilities in community job sites. Eur J Spec Needs Educ. 2008;23(3):269–279.

[9] Spriggs A, Gast DL, Ayres K. Using picture activity schedule books to increase on-schedule and on-task behaviours. Educ Train Dev Disabil. 2007;42(2):209–223.

[10] Shane HC, O'Brien M, Sorce J. Use of a visual graphic language system to support communication for persons on the autism spectrum. Perspect Augment Altern Commun. 2009;18(4):130–136.

[11] Donato C, Spencer E, Arthur-Kelly M. A critical synthesis of barriers and facilitators to the use of AAC by children with autism spectrum disorder and their communication partners. Augment Altern Commun. 2018;34(3):242–253.

[12] Zimmerman KN, Ledford JR, Gagnon KL, et al. Social stories and visual supports interventions for students at risk for emotional and behavioral disorders. Behav Disord. 2020; 45(4):207–223.

[13] AAC-RERC. Mobile devices and communication apps; 2011. [cited 2021 Aug 26]. Available from: http://aac-rerc.psu.edu/index.php/pages/show/id/46

[14] Schlosser RW, O'Brien A, Yu C, et al. Repurposing everyday technologies to provide just-in-time visual supports to children with intellectual disability and autism: a pilot feasibility study with the Apple Watch®. Int J Dev Disabil. 2017; 63(4):221–227.

[15] Carmigniani J, Furht B, Anisetti M, et al. Augmented reality technologies, systems and applications. Multimed Tools Appl. 2011;51(1):341–377.

[16] Kang Y, Chang Y. Using an augmented reality game to teach three junior high school students with intellectual disabilities to improve ATM use. J Appl Res Intellect Disabil. 2020;33(3):409–419.

[17] McMahon DD, Smith CC, Cihak DF, et al. Effects of digital navigation aids on adults with intellectual disabilities: comparison of paper map, Google Maps, and augmented reality. J Spec Educ Technol. 2015;30(3):157–165.

[18] Keshav NU, Salisbury JP, Vahabzadeh A, et al. Social communication coaching smartglasses: well tolerated in a diverse sample of children and adults with autism. JMIR Mhealth Uhealth. 2017;5(9):e140.

[19] Liu R, Salisbury JP, Vahabzadeh A, et al. Feasibility of an autism focused augmented reality smartglasses system for social communication and behavioral coaching. Front Pediatr. 2017;5:145.

[20] Keshav NU, Vahabzadeh A, Abdus-Sabur R, et al. Longitudinal socio-emotional learning intervention for autism via smartglasses: qualitative school teacher descriptions of practicality, usability, and efficacy in general and special education classroom settings. Educ Sci. 2018;8(3):107.

[21] Kanstrup AM, Madsen J, Nøhr C, et al. Developments in participatory design of health information technology - a review of pdc publications from 1990-2016. In: Kanstrup AM, Bygholm A, Bertelsen P, editors. Participatory design & health information technology. Amsterdam: IOS Press, Incorporated; 2017.

[22] Bryant L, Bailey B, Hemsley B. Co-designing augmented reality applications for children with communication disability: opportunities, barriers, and feasibility. Speech Pathology Australia National Conference; 2021 31 May–2 June; Melbourne, VIC.

[23] Radkowski R, Herrema J, Oliver J. Augmented reality-based manual assembly support with visual features for different degrees of difficulty. Int J Hum Comput-Interact. 2015; 31(5):337–349.

[24] Upskill. Boeing cuts production time by 25% with skylight on glass; 2017. [cited 2021 Aug 12]. Available from: https://upskill.io/wp-content/uploads/2016/12/upskill_boeing_case_study.pdf

[25] Coggan M. The robots are coming (to support people with disability into work): Pro Bono Australia; 2021. [cited 2021 Aug 10]. Available from: https://probonoaustralia.com.au/news/2021/07/the-robots-are-coming-to-support-people-with-disability-into-work/

[26] Microsoft. Microsoft HoloLens 2: For precise, efficient hands-free work 2022. [cited 2022 May 7]. Available from: https://www.microsoft.com/en-us/hololens

[27] Ellis C, Adams TE, Bochner AP. Autoethnography: an overview. Hist Soc Res. 2011;36(4(138):273–290.

[28] Microsoft. Dynamics 365 guides 2021. [cited 2021 28 June]. Available from: https://dynamics.microsoft.com/en-au/mixed-reality/guides/

[29] Bryant L, Estela L, Hemsley B. InterPlay. Sydney (Australia): University of Technology Sydney; 2021.

[30] Maylyan M, Reynolds-Haertle R, Holmes B, et al. Overview of dynamics 365 guides: Microsoft; 2021 [cited 2021 Sept 1]. Available from: https://docs.microsoft.com/en-us/dynamics365/mixed-reality/guides/.

Appendix 1.

The 14 steps of the "making tea" visual support guide

Step	Text instruction	Media	3D parts
1	Find a cup. Cups are located in the cupboard marked "!" Open the cupboard.	Video of user opening the correct cupboard.	• An exclamation point to mark the correct cupboard. • "X" symbols to mark incorrect cupboards. • Straight arrows to direct user to cupboard.
2	Take a cup and place it on the sink.	Video of user taking cup and placing on the sink.	• A hand grabbing the cup. • A circle target zone of to place the cup. • An arrow directing the user to the target zone.
3	Find the tea and sugar. They are located in the cupboard marked "!" Open the cupboard.	Video of user opening the correct cupboard.	• An exclamation point to mark the correct cupboard. • "X" symbols to mark incorrect cupboards. • Straight arrows to direct user to cupboard.
4	Take 1 tea bag from the green box. Take 2 sugars.	A photograph of the required tea and sugar.	• Arrows to point to the tea and sugar. • The numbers "1" and "2" to indicate the number of each needed.
5	Empty the 2 sugars into the cup. Place the teabag in the cup	A video of the user placing the teabag and sugars in the cup.	• An "insert" symbol with an arrow directing the used to a target zone of the cup.
6	Place the cup below the hot water tap.	A photograph showing the cup sitting in the correct place below the instant hot water tap.	• A circle target zone of to place the cup. • An arrow directing the user to the target zone.
7	Press the button to fill the cup with hot water. Be careful!	A video of the user filling the cup.	• A hand pointing to the hot water dispense button.
8	Pick up the cup using the handle. Place it on the sink.	Video of user taking cup and placing on the sink.	• A hand grabbing the cup. • A circle target zone of to place the cup. • An arrow directing the user to the target zone
9	Use a spoon to stir the tea.	A video of the user taking a spoon and stirring the tea.	• A dashed circle highlighting the spoon. • A straight arrow pointing to the cup. • A circular arrow indicating a stirring motion.
10	Find the milk. It is located in the fridge. Open the fridge.	A video of the user opening the fridge.	• An exclamation point to mark the correct cupboard. • Straight arrows to direct user to the fridge.
11	The milk is in the door. Take the milk back to the sink. Don't forget to close the fridge.	A photograph of the user picking up the milk.	• A dashed circle highlighting the milk. • A straight arrow pointing back to the sink. • A target zone on the sink of where to place the milk.
12	Pour a small amount of milk into the tea.	A video of the user pouring milk into the tea.	• A hand grabbing the cup. • A half-circle arrow indicating the tip and our motion.
13	Put the milk back in the fridge.	A video of the user returning the milk to the fridge.	• Straight arrows to direct user to the fridge.
14	Use a spoon to stir the tea.	A video of the user taking a spoon and stirring the tea.	• A dashed circle highlighting the spoon. • A straight arrow pointing to the cup. • A circular arrow indicating a stirring motion.
End	Congratulations! You've successfully completed this guide. Enjoy drinking your tea!	None	• A tick image over the tea indicating completion.