Comic Spin: A Comic Creation Tool Enabling Self-Expression for People with Aphasia

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Comics, with their highly visual format, offer a promising opportunity for people who experience challenges with language to express humour and emotion. However, comic creation tools are not designed to be accessible to people with language impairments such as aphasia. We report the design and exploration of *Comic Spin*, an app for people with aphasia that supports the creation of comic strips by constraining the creative space. We explored the use of *Comic Spin* in two studies involving creative workshops. Findings showed that people were able to use *Comic Spin* successfully to create a range of narrative, humorous and subversive comic strips, and that these enabled people to self-express in ways that went beyond the content of the comic strips themselves.

CCS Concepts: • **Human-centered computing** → *Accessibility design and evaluation methods*; **Accessibility**; **Accessibility technologies**.

Additional Key Words and Phrases: Comic Spin, aphasia, accessibility, comics, constrained creativity, creativity support tools.

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1 INTRODUCTION

Creative activities can enable people to express themselves and to broach topics that might be challenging or uncomfortable to address with words alone. This "*making as expression*" is a particularly powerful tool for those who find communication difficult [25]. It has the potential to benefit self-esteem [18] and general mental health [10].

We set out to explore creative activities involving comics. Comics most obviously afford the expression of humour, but they also enable people to address more serious topics such as creative responses to dementia care [20]. With their highly visual format, comics offer a promising opportunity for people who experience difficulties with language, including people who have aphasia. However, creating a comic is not without its challenges. In this digital age, comic creation tools are a popular option to help address these challenges but have not been designed to be used by people with aphasia.

In this paper, we report the design of *Comic Spin*, a comic creation tool for people with aphasia, and two studies to explore (a) whether *Comic Spin* was effective in enabling people with aphasia to create comic strips and (b) how people with aphasia used *Comic Spin* for self-expression. The first study looked at short-term use and the second study looked at use over a more sustained period of

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time. The design of *Comic Spin* drew on the concept of *constrained creativity* applied previously in other work on other creative tools for people with aphasia. These constrained creativity tools offer limited choices and structured processes to enable people with aphasia to engage in creative writing [31] and in the creation of rich multimedia content [32].

This article is an expanded and revised version of [46] originally presented at the ASSETS 2020 conference. It differs from [46] in the following ways: the description of the *Comic Spin* app has been updated, the account of the design process has been reduced, additional results are reported from the first study exploring the effectiveness of *Comic Spin* and how it was used for self-expression (Section 5) and a second study has been added (Section 6).

2 BACKGROUND

2.1 Aphasia and Tools for Creativity and Self-Expression

Aphasia is a language impairment. It is most commonly caused by a stroke that results in damage to the parts of the brain that are responsible for language. People with aphasia may experience challenges with reading, writing, speaking or listening. Aphasia will often affect more than one of these aspects of language. Aphasia affects everyone differently. For example, some people might find speaking more challenging than writing or vice versa. Aphasia affects approximately one third of stroke survivors [2] and the number of people living with aphasia is likely to increase in future years, given the increasing number of people in the world living to an age where stroke is more likely. This means that an increasing number of people will lose the language skills that support them in engaging with both creative activities and digital technologies.

With regard to creativity, people with aphasia generally do not experience a change in their intellect [2] and therefore their creativity remains intact. However, while we can find examples of retained creative self-expression through both visual art [33] and music [52], it is often the case that creative expression relies on language. Within non-digital creative expression, there is evidence that additional support can help. This is beautifully demonstrated by the poet Carol Ireland, who has aphasia, and is supported by an editor – a friend who helps Carol to edit her work [22, 23].

In the context of digital technologies, the barriers posed by aphasia are clearly evident. Many digital technologies are challenging for people with aphasia [27, 37] due to their language demands. Even commonplace tools such as social media platforms can present significant barriers [19, 36]. The Snapchat social media platform has been explored as a tool to support expression and engagement between users with aphasia [3]. Researchers found that with hands-on training and a reference manual, users with aphasia were able to post images online but that they were unanimously dissatisfied with the tool as a means of engaging with peers. Some digital tools however, have been specifically designed to be accessible to people with aphasia. These have mostly focused on language rehabilitation [34], on functional activities such as conversation support [24, 48, 50] and on non-language-based communication [1, 8, 28]. Our recent work has begun to consider how digital tools can support people with aphasia in being creative. We have designed CreaTable [32], a tangible platform for people with aphasia to create and curate multimedia digital content, and MakeWrite [31], an app that supports people with aphasia in creative writing. We have also explored how people with aphasia might build upon their skills in physical visual art (e.g. painting), with an app called Inker [30]. These tools introduced the idea of *constrained creativity* as a way of making creativity tools accessible to people with aphasia and were co-designed using techniques including co-created personas [7, 29], collaborative evaluation and other co-design methods [51].

2.2 Constrained Creativity and Creativity Support Tools that Use Constraints

Enforced constraints are an established technique for supporting creative processes [40]. The 'blank page' of possibilities is often viewed by creatives and non-creatives alike as a major block to creativity. Therefore, people sometimes enforce strategic or arbitrary constraints to provoke and explore initial creative ideas. One of the 20th century's leading composers, Stravinsky [42] (pg. 60), describes this in detail when reflecting on his creative process. He notes that it is often the freedom of choice which challenges creativity, and that limiting the possibilities of a creative space 'frees the creative spirit'. Creative constraints are seen in many domains. A composer might limit themselves to a finite set of notes, as in Schoenberg's serialism. A painter might limit themselves to one type of brush stroke, as in impressionistic art. A writer might limit themselves to a small, finite set of words, as in Dr. Seuss's *Green Eggs and Ham*, where a story is told using only 50 words [38].

Many digital creativity tools utilise constraints as a means to support creativity. They utilise "*creativity-focused features*" [17] to "*positively influence users of varying expertise in one or more distinct phases of the creative process*" (ibid.). These features might support users in negotiating particular aspects of creativity that are challenging for them. Painting with Bob [4] supports digital painting by providing guides so that users always paint 'within the lines' of existing pictures. Bengler and Bryan-Kinns [5] and Coughlan and Johnson [11] describe tools that limit the options that a user is given when playing music, again to ensure that they are successful.

As mentioned above, we have applied the concept of *constrained creativity* to creativity tools for people with aphasia. The MakeWrite [31] app supports people with mild/moderate aphasia in creative writing by 'erasing' pre-existing texts to offer a limited set of words that the user can 'arrange' to create something new. CreaTable [32] similarly uses the concept by offering the user a limited set of tangible multimedia objects that can be arranged on a tabletop computer and then played in a repeating loop, thus supporting people with more severe aphasia in multimedia content creation. Inker [30] allows users to import a piece of visual art they have created, and then use its features (e.g. its colours) to create novel digital art. The knowledge we gained around the concept of constrained creativity for accessible digital creation tools was influential in the design of *Comic Spin*.

2.3 Comics and Comic Creation Tools

A comic is, in essence, a collection of images that tell a story. Comics often contain text, although this is not always the case. They are highly diverse in content, form and sentiment. Small comics, consisting of a limited number of *panels*, are often referred to as *comic strips*. Comics are effective tools for the expression and negotiation of ideas, including, but not limited to, humour. They have been used to convey research findings [35] and complex emotive ideas, for example through visual Hay(na)ku [6] forms[1] and stories about caring for loved ones with dementia [20]. Comics also have the potential to be an accessible form of content for people with aphasia as the combination of pictorial and textual elements is likely to support wider access than either modality in isolation.

We explored a number of digital tools for the creation of comics, or comic-like content, prior to developing *Comic Spin*. StoryboardThat [41] is a website which supports the creation of comic strips consisting of up to 24 panels, allowing for extensive customisation. Users can add components such as characters and infographics by selecting them from a three-level hierarchy and dragging and dropping them onto their comic strip. If a user wants to add text to their comic strip, this is achieved by typing into text boxes and speech bubbles – there are no predefined words or phrases. Canva [9] is web-based design tool with many features including a comic strip maker. When creating a comic, five categories of components can be chosen from a two-level hierarchical menu on the left of the

[1]Hay(na)ku are a form of structured poetry created by Filipino poets, including Eileen R. Tabios.

page. These can be dragged and dropped onto the user's blank comic strip. MakeBeliefComix [26] is another website that builds comic strips consisting of up to 18 panels. Like StoryboardThat, it relies entirely on text that is input by the user. To add a component to a comic strip, the user must first select the target panel, click the desired component, and then drag and drop that component onto their strip. Explosm RCG [16] is a simple comic strip generator. It limits users to exactly three, pre-designed panels. Images and text within these panels cannot be changed. To customize a comic strip, users can lock panels they like and click a button which randomly selects one two or three new panels to replace those that were not locked. 'Cartoon Comic Strip Maker' and Comic Strip! Cartoon & Comic Maker are [12] [43] mobile applications which support the creation of comics, allowing the user to select pictures and add text bubbles, again typed by the user.

These tools were not designed for people with language impairments and include many features that do not conform to accessibility guidance for aphasia [19] and which have been shown to make digital technologies challenging for people with aphasia, such as complex language, lengthy user journeys, distracting/complex interfaces and ambiguous, unlabelled icons. Only Explosm RCG shows promise in terms of these criteria. However, this tool offers no control over the content of comic strips, only supporting the creation of randomised comic strips from a set of pre-made content. *Comic Spin* builds upon many of these comic creation tools, but with the needs of people with aphasia at the fore.

3 COMIC SPIN

Comic Spin is a tablet-based (iOS and Android) application for people with aphasia[2]. It supports the creation of short comic strips through a three-step process: choosing the comic strip's length, choosing themes, and selecting cartoon images and text captions (Figure 1). *Comic Spin* uses the idea of constraining creativity by limiting the size of comic strips, by offering a fixed set of choices for images and captions and by limiting the number of choices. It was designed to be accessible to people with aphasia by providing a highly-structured user journey, using minimal language, having a clean and consistent design, and including read-aloud functionality.

Comic Spin opens on a landing screen which contains only the logo and a "Start" button. An overview screen then summarises the three main steps to create a comic strip. In the first step, the "Choose number of panels" screen, users decide how long their comic strip will be – one, two or three panels (Figure 1a). In the second step, the "Choose themes" screen, users select up to six themes (Figure 1b). This determines the types of images and captions that will be available. For example, selecting the "Animals" theme will give users a selection of animal-related images such as a person playing fetch with a dog and captions such as "*Woof*" or "*So cute*". Irrespective of whether or not any themes are chosen, a default selection of generic images and captions is always included. In the third step, the "Scroll to make a comic" screen, users create their comic strip (Figure 1c). Depending on the selected number of panels, this screen will contain one, two or three pairs of spinners. Users "spin" these to view and select theme-based images and captions. Users may press a "Read" button at the bottom of the screen to have their caption selections read aloud. The final screen of *Comic Spin* reveals the completed comic strip (Figure 1d) with another "Read" button and an option to "Save or Share". Pressing "Save or Share" will open the device's default share window, allowing users to save or share their comic strip to other applications.

This version of *Comic Spin* was used in study 2 (reported in section 6) and differs from the version reported in [46] in several ways: it has a native save/share function, the user interface has been updated with larger images on the themes buttons, the buttons are screen-reader-friendly, it is

[2]See blogs.city.ac.uk/inca/comicspin for information on how to access the app. These details are correct as of 11th of June 2021

responsive to screen size and additional non-verbal caption options such as *"..."*, *"!!!"* and *"???"* have been added.

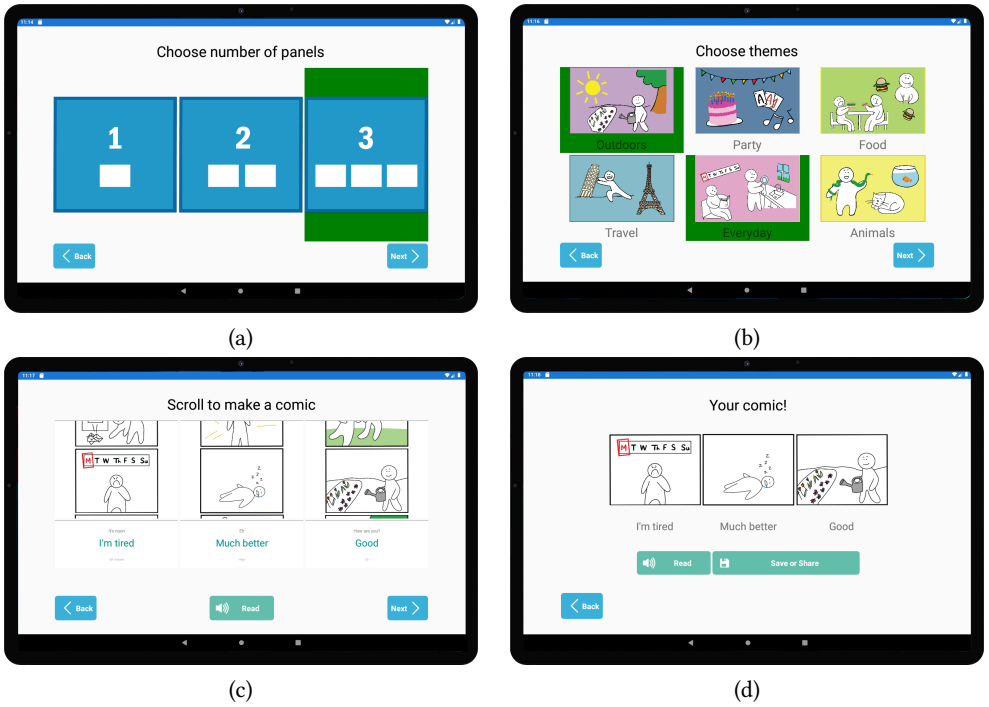

Fig. 1. The key steps in creating a comic strip: (a) choosing the number of panels, (b) choosing themes, (c) selecting images and captions, and (d) viewing the completed comic strip.

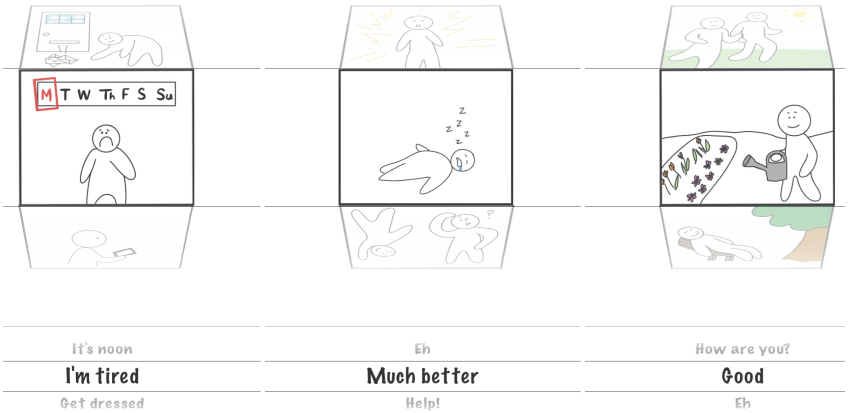

Fig. 2. This larger view of Figure 1c depicts the spinners for creating a three-panel comic. Panel 1 shows a person on Monday with the caption, "I'm tired". Panel 2 shows a person taking a nap with the caption, "Much better". Panel 3 shows a person gardening with the caption, "Good".

4 DESIGNING COMIC SPIN

We set out to explore how the idea of computationally-supported constrained creativity, first used in [31] as an approach to designing creative technology for people with aphasia, could be applied to a comic creation tool. Within this overarching paradigm, we followed a Design Thinking [14] process because of its focus on empathy and creative ideation. This process (empathize, define, ideate, prototype and test) is described in detail in [46] and summarised here (Figure 3) along with key findings.

Fig. 3. The Design Thinking process used to create Comic Spin.

4.1 Empathize and Define

Interviews with proxies and first-hand accounts from people with aphasia were used to build an understanding of the intended user group and to define goals for the design of *Comic Spin*.

4.1.1 Interviews with Proxies. The use of proxies has been shown to be effective in designing for people with aphasia [8] when access to users is limited, as was the case in the initial design of *Comic Spin*. Two researchers with expertise in human-computer interaction and speech and language therapy were interviewed to learn about their experience designing technologies with and for people with aphasia, including the MakeWrite and CreaTable tools [31, 32]. These two researchers (AR and TN), who are also authors of this paper, were not otherwise involved in the initial design and development of *Comic Spin*, but led the testing reported in section 4.4 and were involved in the studies described in sections 5 and 6.

Key findings from these interviews directly influenced the design of *Comic Spin* and some are also generalisable to the design of other technologies for people with aphasia. The findings are listed below in **bold** alongside their impacts:

- **One constraint that can enable creativity is providing a finite set of options**. In *Comic Spin*, users can choose only a fixed number of panels and can only choose content from a set of predefined images and captions.
- **One task should be presented at a time and it should be clear what that task is and how to do it.** Each of the three main steps in creating a comic strip is presented on a separate screen of the app.
- **It should be clear where each task fits into the whole of the application.** The instructions screen gives an overview of the app using the exact screen headers to help users understand where each task fits into the overall process.
- **The interaction should not require very fine motor skills.** The target size of all clickable items on the app is large. Only two major interactions are required to navigate the app itself: tapping and sliding.
- **Users will want choice and choice can enable a wider variety of people to use an app.** Users can choose the length of their comics and their themes from the predefined options. They can choose to caption their images or not.

- **Simple language should be used, with readable fonts and sizes.** Sans serif fonts are used, in large sizes. There is minimal language in the user interface. Captions for comic images are short and mostly simple. All icons are accompanied by a simple text label, as indicated in [19].

4.1.2 Voices of People with Aphasia. Descriptions of life with mild to moderate aphasia from YouTube videos [44, 45, 47] created by people with aphasia and a paper [36] co-authored by a person with aphasia were used to develop empathy with the intended users and to focus the goals and requirements of *Comic Spin*. Key takeaways included:

- **Complex inputs like drop-down menus can be difficult to use.**
- **Limiting typing can improve access to technology.**
- **Simple language and design will help maintain engagement.**

These were guiding principles throughout the design process to enhance accessibility. For example, *Comic Spin* exclusively uses simple forms of input in the form of large buttons and spinners. As mentioned above, to limit typing and constrain choices, a set of text captions was included and the language used in the captions is straightforward. However, it was also important to balance these constraints against providing sufficient richness for the users to express their ideas and feelings. Thus, a wide variety of images and captions were included.

4.2 Ideate

An ideation session was held to generate and explore potential designs. This was hosted at City, University of London with four postgraduate students who had a background in interaction design. The main activity of the session was based around Challenging Assumptions [13]. Key findings from the ideation workshop and their impact on the design of *Comic Spin* were:

- **Give users choices when interacting with the application.** This reinforced a finding from the proxy interviews. In *Comic Spin*, users choose their comics' length, themes and whether they want to use captions alongside their images.
- **Give users the ability to customise the content they create.** This informed the decision to separate text captions from images so that users could choose their own combinations.
- **Consider organising components (images and captions) into categories.** Themes are used in *Comic Spin* to group images and captions.
- **Could be more usable and fun to not start from a blank slate.** The use of spinners on the comic creation screen means that there are default selections of images and captions.
- **Could be more usable and fun to limit options.** Instead of creating their own images and captions, users select from provided options.
- **Remember that people may want/need different things from the application.** Themes enable users to create comics with different content. Default themes allow users to bypass this step if they find theme selection uninteresting or difficult.

4.3 Prototype and Test

Several iterations of paper-based wireframes and digital prototypes were built using Adobe Illustrator and XD and evaluated with expert proxies and usability experts. The findings and design decisions from this were as follows:

- **Interactions should have clear, direct consequences.** Each user interaction triggers a concrete action in the app. For example, when choosing comic length, users are presented with options for "one", "two" or "three" panels rather than options to "add a panel" or "remove a panel". Adding one panel to a one-panel comic strip would result in a different-length comic

strip than adding one panel to a two-panel comic strip, and therefore, requires abstraction on the part of the user.

- **Certain interactions like "locking" images may be too complex.** Some prototypes presented users with several images and captions and allowed them to "refresh" to see more while "locking" those that they wanted to keep.
- **Default selections can make an app usable to a wider variety of people.** The app defaults to three-panel comics with a generic set of images and captions that do not correspond to a theme.
- **Separating the choices for length and themes could simplify the app.** One prototype presented multiple comic strip settings on a single screen. This was changed so that length and theme choices are on separate screens, guiding users to make one decision at a time.
- **Selected images should be more prominent than "un-selected" images to focus attention on the selected images.** Image spinners are sized so "un-selected" images are smaller, but still visible.

4.4 Test: Collaborative Evaluation with People with Aphasia

Based on the feedback from expert proxies and usability experts, a first prototype of *Comic Spin* was implemented and evaluated. The aim of the evaluation was to find out whether people could use the app successfully and whether they encountered any usability issues.

4.4.1 Method. Three people with aphasia (Carol, Charlie and Evelyn) participated in the evaluation[3]. Their ages ranged from 55 to 65 years old. All were at least six months post-stroke and had spoken English fluently prior to their stroke. They had moderate to severe language difficulties associated with aphasia, with spoken language being very limited for two participants (Carol and Charlie). These two participants also experienced limb weakness (hemiplegia) affecting their right arms and both used a stick to walk.

The evaluation took place in a workshop setting. *Comic Spin* was first demonstrated to the participants by a speech and language therapist (SLT) researcher with extensive experience of supporting access to technology for people with aphasia. Each participant then used the app individually with support from a member of the research team. After use, individual feedback was captured through discussion, supported by a large piece of paper with rating scales. We asked participants whether they would like to use the app again, whether the app was easy to use or not, how they felt about each screen of the app, whether they would like to share their comic strips online and the importance of a read-aloud feature.

4.4.2 Evaluation Findings. All 3 participants were successful in making comic strips with the app. They created a total of five comic strips. Three comic strips had three panels, two had two panels. The comic strips were typical of the participants in the workshop. For example, Carol[4], who disliked using or engaging with written words, made comic strips with very few captions - such as the holiday-themed strip in Figure 4.

The feedback from the session indicated that all participants enjoyed *Comic Spin* and wanted to use it again. Feedback about its ease of use was mixed. While Charlie felt it was easy to use, the other two participants (Carol, Evelyn) had reservations and rated its ease of use as 'neutral'. Participants were effective in choosing themes and images for their comic strips, but two (Carol, Charlie) were not confident about adding captions.

[3]The evaluation of Comic Spin and the two studies received ethics approval from City, University of London.
[4]Gender-neutral participant pseudonyms have been used throughout this work to maintain anonymity.

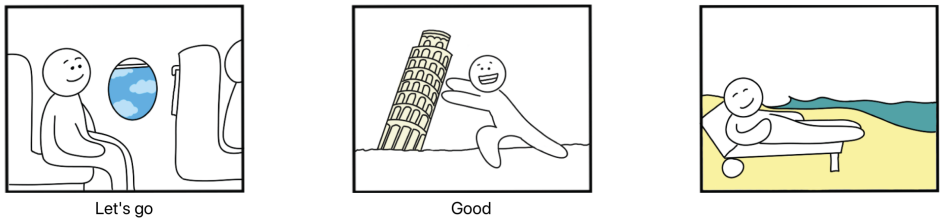

Fig. 4. Carol's holiday themed comic.

While there was a general consensus amongst participants that they wanted to be able to add their own images, one participant (Carol) was strongly against adding their own words as this would be a challenge. All participants were very strongly in favour of integrating a read-aloud feature into the app – in fact when asked to rate out of 5 how important this would be, they said it should be a "*6 out of 5 priority*". Finally, participants all expressed a strong desire to share their comic strips online in some way. Other feedback delivered specific insights into how to improve the user interface to make it more accessible. Participants found some of the smaller interface elements challenging to interact with. Evelyn suggested that we should make the pictures in the spinners larger.

In response to the feedback gained during this evaluation, we made changes to the fonts, sizes of pictures in the spinners and the size of the buttons. Based on the discussion about a read-aloud feature, we also added a dedicated text-to-speech button which played aloud the selected caption in the spinner. This was preferred over the alternative of reading aloud every time a new word is highlighted. This delivered a new version of *Comic Spin* that was used in Study 1.

5 STUDY 1: EXPLORING SELF-EXPRESSION IN A CREATIVE WORKSHOP

We conducted a first study to answer two research questions: (a) Is *Comic Spin* effective in enabling people with aphasia to create comic strips? and (b) How do people with aphasia use *Comic Spin* for self-expression? The study took the form of a creative workshop.

5.1 Participants

Eight participants with aphasia took part in study 1 (Alex, Jo, Hilary, Pat, Ceri, Jodie, Dom and Dev [Table 1]). None had taken part in the earlier evaluation session. Participants' ages ranged between 47 and 68 years old. All participants had a clinical diagnosis of aphasia, were at least six months post-stroke and had spoken English fluently prior to their stroke. Participants had a range of aphasic language difficulties as a consequence of their strokes – representative of the wider population of people living with aphasia. Participant scores on the Frenchay Aphasia Screening Test (FAST [15]) ranged between 19 and 29. The FAST provides a very brief assessment of ability in reading, writing, speaking and understanding of speech. A lower score indicates a greater level of impairment. Three participants scored above the FAST cut-off for their age group - indicating that their performance was within normal limits for a person of their age. Nonetheless, all participants reported experiencing some level of impairment due to aphasia. Spoken word-finding ability was very limited for one participant (Dom), other participants had milder difficulties with spoken language. Several participants experienced mild to moderate difficulties in understanding spoken language and one participant reported specific and significant difficulties with reading (Jodie). Five participants had hemiplegic limb weakness which restricted the use of their right arms and legs.

Participant	Age (years)	Overall Total on FAST (max score possible = 30) *
Ceri	68	29 (N)
Jo	47	26 (Y)
Hilary	67	28 (N)
Pat	68	25 (N)
Dom	55	21 (Y)
Alex	47	22 (Y)
Dev	56	19 (Y)
Jodie	62	24 (Y)

Table 1. Study 1 participants' ages and scores on Frenchay Aphasia Screening Test (FAST) [15]. *Y/N indicates presence of aphasia according to age-related cut-off scores.

5.2 Procedure

The creative workshop was one in a series of six workshops exploring novel creative technologies with people with aphasia. The workshops took place within the context of an existing community aphasia support group who met weekly at a specialised aphasia centre.

5.2.1 Workshop Session Structure and Data Collection. The workshop was planned and delivered to meet the needs of people with aphasia. Once participants had arrived and were sitting around a large central table, an SLT researcher introduced and demonstrated *Comic Spin* using an iPad connected to a projector. To ensure the presentation was accessible, information was introduced one piece at a time with the opportunity for participants to ask questions or ask for it to be repeated.

Participants then used an iPad either individually, or shared between two, to explore and use *Comic Spin* to create comic strips (Figure 5). Two researchers and an aphasia group volunteer supported participants. After around 15-20 minutes of using the app, participants each completed a short paper-based feedback questionnaire. The questionnaire consisted of four positively worded statements about the experience of using *Comic Spin* and complied with guidance regarding making text accessible for people with aphasia [21]. Next, the SLT researcher facilitated a group discussion about *Comic Spin*, documenting participants' comments on large sheets of flip-chart paper and ideating suggestions for potential future refinements. Exploration of the app was then drawn to a close in order to break for coffee. Approximately four weeks after the end of the workshop series, participants were individually interviewed by experienced SLT researchers independent to those who had run the workshops in order to gather feedback about the technologies including *Comic Spin*. These exit interviews, initially intended to be undertaken face-to-face within a week of the workshop series ending, were delayed by the onset of the COVID-19 pandemic. The interviews were carried out online, via video-conferencing, after an amendment to the study's ethics application had been approved.

5.2.2 Data Analysis. We analysed the comic strips produced in the creative workshop, compiled the data from the feedback questionnaires, analysed the transcript from the group discussion and undertook structured observation of video data of participants using the app. The exit interviews were transcribed and subjected to a thematic analysis to explore positive and negative views about the app, comments about the implications of constraints on the process of creativity and suggestions for future refinements. Data under each theme were summarised and reported. We did not log the time spent using the app, or the number of choices made within the app, as these data would have been difficult to interpret due to the group nature of the activity.

Fig. 5. Workshop participants in study 1 using *Comic Spin*.

5.3 Results: Enabling Creation of Comic Strips

5.3.1 The Comic Strips. The comic creation activity lasted approximately 18 minutes. During this time, 24 comic strips were saved to the iPads. The majority of the saved strips (19) had three panels, four strips had two panels and one strip had one panel. The predominant themes were party (seven strips), animals (five strips), gardening (three strips) and travel (three strips). These choices were heavily influenced by the themes built into *Comic Spin*.

5.3.2 Questionnaire Results. Responses to the feedback questionnaire are shown in Table 2. In total there were 10 instances of 'strong agreement', five instances of 'agreement' and one instance of 'neutrality', indicating that the majority of the feedback was positive.

All participants felt that they "did something creative with the app" (S1). Five out of eight participants strongly agreed with this statement. All but one felt that the app was "*easy to use" (S2).* The majority (five out of eight) strongly agreed that the app was easy to use. Participants enjoyed the experience (S3) but were slightly less positive when asked if they were proud of what they had created (S4).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1) I did something creative with the comic app	0	0	0	3	5
2) The comic app was easy to use	0	0	1	2	5
3) I enjoyed using the comic app	0	0	0	3	4
4) I feel proud of my creation	1	1	0	4	1

Table 2. Likert scale responses from 8 participants in study 1.

5.3.3 Using Comic Spin. The group discussion after using *Comic Spin* explored ease of use and potential refinements. *Comic Spin* was generally praised as being simple to use: "*it was quite straightforward*" (Hilary) and "*good to use*" (Jo). Hilary liked the structure and noted that the constrained choices enabled successful use – "*I like the themes. It gives it a bit more structure. If you have it just open... it is a whole lot of words. Makes it just very hard work.*".

With regard to potential refinements, participants said that they would like more panels for the comic strips – "*More screens. More choices. Not just three. [unclear] so you are making more of a story...*" (Jo). Group consensus was that allowing up to three more panels (i.e. up to six in total) would be optimal. Participants also suggested including more themes and captions "*...there were four phrases for the animal ones, yes? So you might want to have...Lots more, yeah? Yes.*" (Pat) – "*you have to change the language... The words". [researcher – "you would like to put in more words"]. "Yes."* (Ceri). However, participants were aware of the inherent tension between adding more captions and increasing the complexity of the app – "*There is gonna be point where there is too much isn't it? Cause you need to... [scrolling gesture].*" (Hilary). General agreement was that by default there should be a limited set of captions to choose from, but a 'more words' button could be provided and used when the user is short of words.

Participants were generally against the idea of including their own, personal content, but quickly began to ideate new content which might be used in the app. Participants seemed to enjoy the simple comic aesthetic of the pre-made content – "*I liked that it wasn't too much colour and things. It just had little bits of colour.*" (Jo). They suggested that punctuation alone might offer an approach for expression – "*some more... exclamation marks, question marks, not so much words. You can say a lot with an exclamation mark.*" (Hilary). This response received an excited response from Dom "*YES! YES! [points at (Hilary)]*". Hilary later suggested "*a few z z z – sleeping*".

5.3.4 Exit Interviews. Data from the exit interviews indicated that the prevailing sentiment remained - that *Comic Spin* app had been well received by nearly all of the participants. Six out of eight participants reported entirely positive experiences; commenting that they found the app fun and easy to use. One participant reported a mixed experience, stating that whilst they enjoyed using the picture components to build a comic strip, the reading impairment caused by their aphasia meant that they found the "*words difficult*" (Jodie). One participant was more negative overall about the app, observing that the comics format and style of images were not to their taste: "*I would sooner present my pictures to tell their own story*" (Ceri).

In terms of the comic strips created using the app, several participants indicated that they would like to have more than three panels to convey their story. However, they acknowledged that they would find it harder to work with a very large number of panels: "*Can make comic is the one: fine, and, uh, six pieces: fine and, uh, seven and eight: forget it! (laughs).*" (Dom). These findings echo the ideas expressed in the workshop discussion.

In the exit interviews, three participants expressed a desire for more images to select from when composing a comic strip, indicating that greater choice might enable them to be more creative. This is illustrated in the excerpt below from the interview with Dom:

Fig. 6. Alex's comic about gardening, with a twist

Researcher:	And so if they were to make the Comic spin again and change anything Would you want them to change any aspects?
Dom:	And. Uh, And, I don't know! Uh, uh And, uh, changing oh, is uh, much, if uh, longer and and, uh and uh half and uh people is easier, but uh, and um, simple. And, uh. And, uh. And, uh. Much, uh, uh, computer is easy But, uh. And, uh, Ah, Ah God...
Researcher:	No, don't worry
Dom:	Uh, uh. And, uh. Excellent. But, uh More. More, more
Researcher:	So, more kind of options? or...
Dom:	Yes! Yes. Yes, yes.
Researcher:	Of, what you could, what you could put on?
Dom:	Yes. Yes, yes. Yes, yes.
Researcher:	Ok, Yep. What so, you could, kind of, almost be more creative?
Dom:	Yes. Yes. Creative.

5.4 Results: Self-Expression with Comic Spin

In looking at the comics produced, reviewing the session videos and analysing the exit interview data, we see that using *Comic Spin* enabled self-expression. Many of the participants used the content from the themes to present creative, often comical and subversive messages. Alex, for instance, created the comic presented in Figure 6. This was the first comic that Alex created, doing so after about two minutes and 30 seconds of starting to use the app. In discussions with Alex during the session, the researchers assumed that this comic strip was about how Alex used gardening to calm down when feeling annoyed. The researchers were wrong. As Alex explains: "*it is about being annoyed by someone, then putting them 6 feet under*". When asked about his/her thought process when creating this comic, Alex noted "*it was just what I was shown*", implying that s/he had not actively decided to conjure up this story, but that it was simply what had 'jumped out' at them when using the app. This comic was very positively received by the group, indicated by laughter and a discussion about the apparent innocence of the third panel in contrast to its underlying darkness.

Fig. 7. Hilary's real-life story re-tell.

Other comic strips reflected real-life experiences, presented in alternative or comical ways using the content within *Comic Spin*. Hilary created the comic strip shown in Figure 7, which s/he entitled 'Surprise Proposal'. S/he used this strip as a way of announcing to the group that their son was

getting married. Reflecting on the comic strip, they provided the following context to the group: "*That is my son and prospective daughter-in-law having being proposed to. He proposed to her as a surprise, then we all got together and had a meal and a surprise party*", promoting discussion with other participants. They then, instead of taking a screenshot with the iPad, took a picture of the comic strip with their phone to show their family and sent it via Whatsapp.

6 STUDY 2: ONLINE CREATIVE WORKSHOPS

In Study 2, we explored the use of *Comic Spin* in a series of three online workshops carried out alongside independent at-home practice[5]. The aim was to collect further data to answer the two research questions ((a) Is *Comic Spin* effective in enabling people with aphasia to create comic strips? and (b) How do people with aphasia use *Comic Spin* for self-expression?) but focusing on what happens when the app is used independently and over a longer period of time. In addition, given previous research about the barriers that social media platforms can present for creative expression by users with aphasia [19, 36], this study enabled us to explore whether participants could use *Comic Spin* to share their created comic strips onto a public forum (Twitter).

6.1 Participants

Four participants with aphasia took part (Hilary, Pat, Dev and Robin [Table3]). Three had taken part in study 1 (Hilary, Pat and Dev). One (Robin) had not taken part in study 1 but had taken part in other creative workshops in the original in-person workshop series. Participants had a range of aphasic language difficulties. Spoken word-finding ability was very limited for one participant (Robin). Others had milder difficulties with speech. Participants experienced mild to moderate difficulties in understanding spoken language and mild to severe difficulties in understanding written language. Participants' ages ranged between 54 and 69 years old. All had a clinical diagnosis of aphasia, were at least six months post-stroke and had spoken English fluently prior to their stroke. Three participants reported hemiplegic limb weakness which restricted the use of their right arm and leg. For two participants (Pat and Dev) this impacted on the dexterity of their right hand, and one participant (Robin) reported that they were unable to use their right hand at all.

Participant	Age (years)	Overall Score on FAST (max score possible = 30) *	Use of left and right hands
Hilary	68	28 (N)	Full use
Pat	69	25 (N)	Limited dexterity in right hand.
Dev	57	19 (Y)	Some problems using right hand if tired.
Robin	54	7 (Y)	Unable to use right hand at all.

Table 3. Study 2 participants' ages and scores on Frenchay Aphasia Screening Test (FAST)[15]. *Y/N indicates presence of aphasia according to age-related cut off scores.

6.2 Method

Study 2 took place approximately one year on from the completion of study 1. Three online workshops were conducted via Zoom. The workshops were held once a week, on Mondays, for three weeks and lasted two hours each with a 10 minute break in the middle. Participants were sent Android tablets (Samsung tab A7) in advance. Protective cases (shown in Figure 8) were used

[5]The *MakeWrite* app was also used in the online creative workshops; this is not reported here.

to protect the tablets, but also allowed participants to manipulate and stand the tablets with one hand. The revised version of *Comic Spin* described in section 3 was installed on the tablets, with amendments made in response to study 1. A new Twitter account was set up specifically for this study – @INCACreates – so that participants would be able to share the comic strips they created, without using personal accounts.

Each workshop was facilitated by an SLT researcher and a technology researcher with experience of working with people with aphasia. During sessions, the SLT researcher signed into a second Zoom account so that she could demonstrate live usage of *Comic Spin* on a tablet with a webcam mounted above it (see Figure 9). Instructional videos were used as part of the process of re-familiarising the participants with the app and troubleshooting common problems.

To support participants in addressing any individual technical issues, sessions 2 and 3 included an additional 30 minute drop-in prior to the official start time. All participants were also offered the opportunity to take part in separate one-to-one practice sessions with the SLT researcher to support their access to the technology and the workshops. Two participants opted to take this opportunity. Robin undertook two practice sessions (after session 1 and after session 2) and Dev undertook one (after session 2).

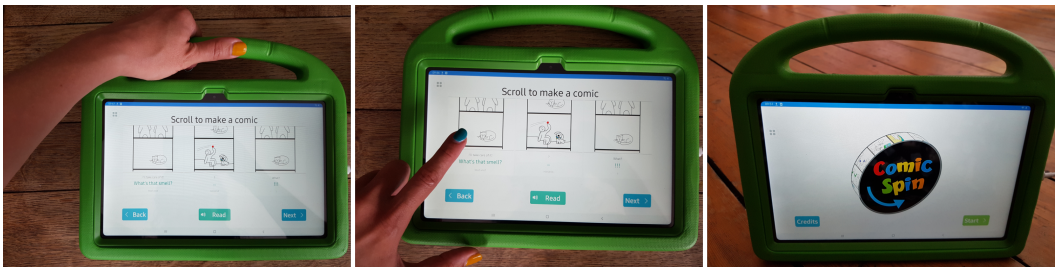

Fig. 8. A tablet in its protective case. We chose cases which could be used with one hand and propped up at a variety of angles to support one-handed use.

6.2.1 Session 1: Back to the App. The main aims of the first session were to re-introduce *Comic Spin*, which had received some minor modifications since the in-person workshop of study 1, and to begin creating some comic strips. Participants were first familiarised with the new tablets and *Comic Spin* through step-by-step, example-led guidance from the facilitators. Participants were then divided into groups of two and placed in breakout rooms – participants with more severe aphasia with the SLT researcher, those with milder aphasia with the technology researcher. Participants were asked to make two comic strips in a highly constrained process, wherein the researcher stepped them through each stage and asked them to make specific choices about the strip – e.g. create a '2-panel comic' using the "outdoors" theme.

Based on this refresher, participants were then encouraged to use *Comic Spin* throughout the following week via a series of daily challenges which were emailed to them in the four remaining days of the week. The challenges for the first week were to 'make a comic which is/about...' - Tuesday: 'happy'; Wednesday: 'Mystery'; Thursday: 'Funny'; Friday: 'Absurd'.

6.2.2 Session 2: Making and Sharing Comic Strips. The main aims of this session were to continue using *Comic Spin* and to share the comic strips with others. After reflecting on the previous week's session and the content created, participants were split into breakout rooms - two participants in each room, each with a member of the research team, as before – then asked to create comic

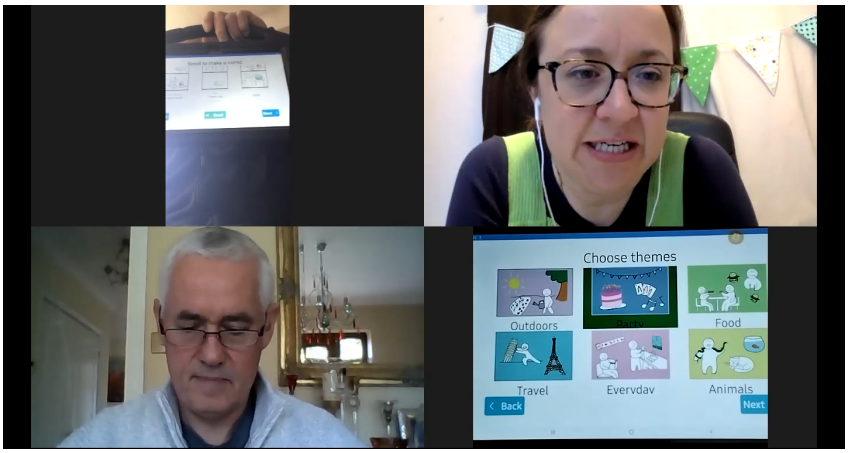

Fig. 9. A typical scene from a breakout room in an online workshop. A participant (top-left) is showing their comic strip to the camera using the handle of the tablet's case. Another participant is pictured in the bottom left. The SLT researcher, pictured top-right, is able to demonstrate use of the app by signing into another Zoom account in which their webcam is mounted on top of a tablet.

strips. Participants were also given instructions on how to share the finished comic strips to Twitter. Figure 9 shows an example of how a typical breakout room looked.

As before, a 'homework assignment' was set with daily challenges – 'make a comic which is/about...' - Tuesday: 'Relaxing'; Wednesday: 'Strong'; Thursday: 'Surprising'; Friday: 'Inspiring'. Participants were encouraged to share their creations to Twitter using the @INCACreates account.

6.2.3 Session 3: Mastery and Curation of Comic Strips. The aims of this session were to continue usage of the app and to curate the content created in the previous sessions. The session began with a review of the content created and shared on Twitter in the last week. The participants then used *Comic Spin* independently. This was followed by a break, after which participants were separated into their breakout rooms. In the breakout rooms they were asked to choose a 'selection' of comic strips which worked well together, or that they liked. Participants then reported back to the whole group with their curations, sharing in whatever way they chose. This week's 'homework assignment' was to create and share further curated selections via the @INCACreates Twitter account - adding additional information if desired.

6.2.4 Data Collection. All workshops were video recorded for subsequent analysis. At the end of each workshop, participants completed a short individual feedback survey, delivered via the Zoom polls feature. They rated individual statements relating to their experience of using *Comic Spin* in the session and answered yes or no to the statement "I made something with Comic Spin that I could not have made without it". All comic strips saved to devices during the workshop series were downloaded upon return of the device. Comic strips shared by participants via Twitter were also captured. Approximately one week after the final workshop, participants each took part in an individual, online exit interview with an independent researcher - to elicit their opinions about the workshop series.

6.2.5 Analysis. Workshop data were analysed by exploring the comic strips saved to devices and tweeted by participants, by compiling data from the in-session feedback surveys and by undertaking descriptive coding of video data of the workshop sessions. Video data were coded by

three researchers, who watched the videos and applied descriptive codes to comments about *Comic Spin* and instances of observed use. Quotes and timestamp information were also captured. These were then discussed. The exit interviews were transcribed and analysed thematically to investigate independent use and self-expression using *Comic Spin*. Data under each theme were summarised and reported.

6.3 Results: Enabling Creation of Comic Strips

6.3.1 The Comic Strips. We analysed the comic strips produced over the 3 weeks of the study (Table 4). A total of 56 comic strips were saved to participants' devices. Forty-one were unique and the remainder were duplicates. Of the 41 unique comic strips, there were 27 three panel strips, 10 two panel strips and 4 one panel strips. All participants created comic strips independently both within and outside of the sessions (18 within sessions, 23 outside of sessions). All participants shared a proportion of their saved comic strips to Twitter (26 in total). Comic strips shared via Twitter did not automatically reveal the identity of the person posting. Participants had the option to add their initials or name in the text of each tweet. Hilary and Pat sometimes used this method to annotate their tweets with either initials or a first name.

P	Total Comics	Total Unique	3 Panels	2 Panels	1 Panel	Session Comics	Non-Session	Shared to Twitter
Hilary	7	6	4	2	0	3	3	4
Pat	7	7	3	1	3	1	6	6
Dev	18	13	9	3	1	5	8	12
Robin	24	15	11	4	0	9	6	4
Totals	**56**	**41**	**27**	**10**	**4**	**18**	**23**	**26**

Table 4. Details of comic strips saved to participants' (P) devices during study 2.

A total of 71 comic strips were tweeted during the study (Table 5). Forty-one were shares of 26 of the saved comic strips (some were shared more than once). Thirty were published straight to Twitter and not saved to an individual device. As these were shared directly to the same Twitter account from multiple devices, we cannot determine which participant tweeted them. We therefore report descriptive data across the whole collection. Of the 30 straight-to-Twitter comic strips, 25 were unique and the remainder were duplicates. Of the 25 unique tweeted comic strips, there were 17 three panel strips, 8 two panel strips and no one panel strips. All participants created and tweeted comic strips independently both within and outside of the sessions (12 within sessions, 13 outside of sessions).

Total comics	Total unique comics	3 Panels	2 Panels	1 Panel	Session comics	Non-Session Days
71	25	17	8	0	12	13

Table 5. Details of comic strips tweeted to the @INCACreates Twitter account during study 2.

6.3.2 Results from In-Session Feedback Surveys. Likert data from the in-session feedback surveys are shown in Table 6. Levels of agreement for all statements ranged from neutral (3) to strongly agree (5) where 1 = strongly disagree, 5 = strongly agree. All participants except Pat indicated that

they had done "*something creative with Comic Spin*" during each session. Reports of ease of use generally increased across the weeks for participants Dev and Robin who moved from a neutral score to either a 4 or 5 level of agreement with the statement "*I found it easy to use Comic Spin*". Levels of enjoyment of use went from neutral/positive to positive for all participants in week three. Levels of satisfaction with what had been made varied from neutral to very positive for the four participants across the course of the workshop series. Hilary and Pat showed more neutral scores and Dev and Robin indicated maximum agreement with the statement "*I like what I made with Comic Spin*" during the 2nd and 3rd workshops. Participants were additionally asked each week whether they felt they had "made something with Comic Spin that I could not have made without it." All participants answered yes to this on all occasions.

	Week 1				**Week 2**				**Week 3**			
	H	**P**	**D**	**R**	**H**	**P**	**D**	**R**	**H**	**P**	**D**	**R**
I did something creative with Comic Spin	4	3	4	3	5	3	5	5	3	3	5	5
I found it easy to use Comic Spin	4	4	3	3	5	4	5	5	5	4	5	4
I enjoyed using Comic Spin	3	4	4	5	4	4	4	5	4	4	5	5
I like what I made with Comic Spin	3	3	4	5	4	3	5	5	3	3	5	5
Made something I could not have otherwise	y	y	y	y	y	y	y	y	y	y	y	y

Table 6. Likert scale responses from four participants in study 2 (H(ilary), P(at), D(ev), R(obin)). 1 = strongly disagree, 5 = strongly agree.

6.3.3 Session Observations: Using Comic Spin. We analysed the three sessions to understand more about the efficacy of *Comic Spin* and what creative behaviours it did, and did not, afford. All participants were able to use *Comic Spin* effectively to produce comic strips in the online workshops, although they used it in different ways. The differences were generally based on their level of aphasia, with the two participants whose aphasia was more severe focusing more on matching the pictures in the panels to captions (e.g. see Figure 10) and creating less 'narrative' comic strips. These can be contrasted with the narrative forms seen in Alex's and Hilary's comic strips (Figures 6 and 7 respectively). However, this is not to say they did not display competency. Robin, whose aphasia was the most severe, when engaging in a tutorial in session one 'jumped forward' to complete their first comic, ahead of the SLT researcher who was demonstrating what to do "*Oh, you've already made one! Wow. OK.*", to which Robin chortled.

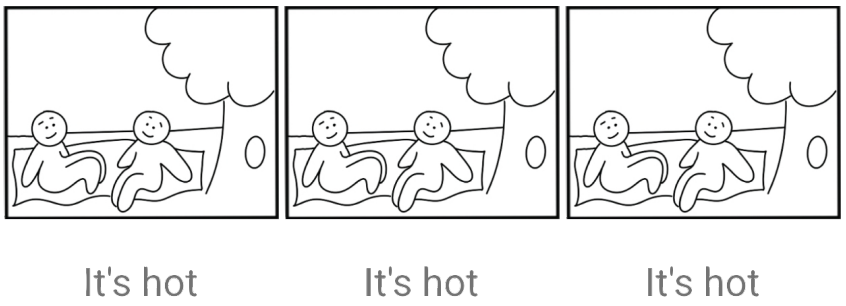

Fig. 10. A comic strip where the creator has matched a caption to an image, in this case duplicated three times.

Although all participants displayed competency, some also struggled with aspects of the user interface. For example, Hilary had some misunderstandings when choosing themes "*I've got I clicked*

animals first. And now I'm changing it to food. But I've got to both of them are both highlighted...". A researcher then explained the concept of toggling off/on themes, which participants learned quickly.

Another issue which arose was the number of choices with regards to content and the need for the user to scroll through and assess all of them - leading to a degree of choice paralysis and a relatively long 'search process'. As Hilary noted: "*I found that it was taking me weeks just to choose, you know, just to ch.... and does that make sense with the next one? And it was I thought, gosh, this has taken me so long for something so simple, but I suppose you want to get it right, don't you?*".

Finally, we saw varied use of the recently added 'Read aloud' feature. Robin – who uses very little spoken language – enjoyed using the feature. Beyond using this feature to read aloud the words they had chosen, Robin used it as a way to capture attention and get a turn in a conversation. They used it in combination with a repertoire of vocal sounds (e.g. singing, humming) to convey an idea. Conversely, Dev wanted to demonstrate their competency in reading aloud the captions of their comic strips, and did so upon completing each one.

6.3.4 Exit Interviews: Using Comic Spin. Hilary, Dev and Robin reported that they found *Comic Spin* easy to use. Pat reported that they find technology in general is difficult to use but derived a sense of achievement from using *Comic Spin* successfully: *"So, I enjoyed using the technology, and I don't find it easy. So, you know, it was that there were feelings of satisfaction for having been able to… to… perform, so, so it was, you know, they were good."*

All participants reported using the app independently at home, without additional support from family members. They used the app between 5 and 7 days per week. Pat only used the app to complete the between session "challenges" but all others practiced with it more. Hilary reported sometimes undertaking additional use depending on energy and motivation levels: *"Normally, I tried to sort of try and do it in the morning. And then I would have a little bit of a play, and uh and then do it. But if it was the end of the day, and I was tired, probably I would just send oh I'll do my homework and that's it, you know."* Everybody commented that the regular, at-home practice made the app easier to use than if they had only used it once a week in the workshops.

All participants said they would recommend the app to other people with aphasia.

```
Researcher3 :   And would you recommend them to other people with aphasia?
Robin:          Hm hm hm *Robin nods then gives thumbs-up*
Researcher3 :   Okay. And, who for? People, like you just at home, or in a group?
Robin:          Um hmm hm *Robin gives thumbs-up*. Doh *gives thumbs-up* do-do-do-do
                *syllables rapidly articulated and combined with motioning around
                a circle to convey 'group'* um uh *Robin gives thumbs-up*
Researcher3 :   Yeah so *overlapping turn*
Robin:          Doh do-do-do *motioning around a circle to convey 'group'*
                oohh *intonation to convey excitement* doh doh doh
                *motions around a circle again*.
Researcher3 :   In a group? Okay.
Robin:          Hm *Robin nods*
Researcher3 :   Okay. So is that both *overlapping turn*
Robin:          Hm *Robin nods*
Researcher3 :   do you reckon then at home *Robin gives thumbs up* and in a group?
Robin:          Hm *Robin gives slight nod*
```

In this excerpt, Robin indicates that *Comic Spin* could be used by people with aphasia both independently and in a group context. Hilary and Pat both indicated that *Comic Spin* might be of

most interest for people with more severe aphasia. They also stated that people's personal tastes and preferences would influence who might enjoy it the most.

6.4 Results: Self-Expression with Comic Spin

6.4.1 Session Observation: Expression through Comic Spin. As in study 1, *Comic Spin* was used in a range of ways, not always directly related to the focus of the workshop session. For example, when asked to create a 'Happy' comic strip, Hilary was not entirely sure whether their comic strip showing someone relaxing in the sun (their idea of happy) was 'happy' – "*Well, I did a comic, but in retrospect, it's not actually particularly happy. Well, sort of happy*". As in study 1, there were a number of instances where comic strips were used to tell a story or describe a concept. For example, Dev used a comic strip to tell the others something about their week – showing a person being ill, but then going out and having a burger and getting better. Robin created and presented a comic strip which said "*it's cold*" then "*it's hot*" and then followed this with "*duh duh duh duh, duh duh duh [in rising and falling intonation]* – implying the changing seasons.

Comic strips also had the potential to trigger debates and discussions between the participants and the researchers, enabling them to connect and tell stories. For example, a comic strip by Dev (Figure 11) that included the leaning tower of Pisa, resulted in the following exchange:

```
Pat:        Has anyone done that...? With the leaning tower of Pisa?
Hilary:     Yeah!
Hilary:     I've got that photo!
Pat:        It never occurred to me I tell you. I've been there about 40 years ago.
Pat:        I had no idea!
Researcher: It's become a bit of a cliché since then maybe...
```

Fig. 11. Comic involving the leaning tower of Pisa.

Finally, in study 1, we saw seemingly innocent comic strips with a dark undertone, such as Alex's subversive 'gardening' comic (Figure 6). In study 2, we saw a natural extension of this with people finding darkness in the innocent comics of others. For example, Robin subverted the meaning of a comic strip created by Dev (Figure 12). Pat commented on it as a pleasant depiction, but Robin turned it into something more macabre:

Fig. 12. A comic strip created by Dev. Pat described this as relaxing, eating and feeding ducks. However, Robin subverted this by essentially reading the panels backwards - implying that the final scene involves luring the duck so that it may be eaten, resulting in the person relaxing.

Pat:	The first one is about relaxing, eating and feeding ducks
Robin:	Yumyumyum!
Researcher_1 :	(reading comic aloud) I'll take care of it [...] so cute...
Robin:	No! Yumyumyum! *rubbing stomach*
Researcher_2 :	So, Robin is eating the duck?
All:	*laughing*
Robin:	*gives the thumbs up*

6.4.2 Exit Interviews: Using Comic Spin to Support Expression. Although all participants had posted comic strips to Twitter, few reported sharing their comics with friends or family members. Participants identified a number of reasons for this. Dev and Robin indicated that they were not sure whether family members would be interested, as they were busy doing their own things. Hilary said they had thought about it, but not got round to sharing the comic strips with their spouse. Pat and Hilary both identified that it was impractical to physically share examples with their children due to the COVID-19 restrictions limiting the amount of contact that was possible with people outside the household. Pat further reported: "*I didn't think if they were to make um you know, if the car cartoons was comic or amusing*" indicating that they did not find their creations sufficiently humorous to share.

In spite of limited sharing with family, all participants actively visited the Twitter feed to look at the comic strips shared by other group members:

Researcher_3 :	So you you did see other people's [comics on Twitter]?
Robin:	Hm hm *Robin nods* *overlapping turn*
Researcher_3 :	Yeah, yeah. Were you interested in what they'd come up with?
Robin:	Hm! *Robin vigorously nods head and gives thumbs-up*

Dev and Robin, however, both reported some challenges fully engaging in this way due to reading difficulties. Pat hinted that the sharing comic strips via a mutual Twitter feed promoted social interaction between group members: "*It's interesting that sort the, the way it was you were able to see, to pool the results if you like. So that that was interesting. And yes, I was curious, you know, to put it bluntly, I was kind of wondering whether anyone else had come up with anything sort of funnier, or more instructive, you know, than I had, you know, so there was a kind of element of competition,*

which, you know, in which I'm not going to, I'm not uh... just a twinge, a twinge, that's all and so, you know, it was I suppose that's what social interaction is."

7 DISCUSSION

7.1 Efficacy of Comic Spin

The speed and the efficacy with which people were able to create short comic strips, coupled with the findings from observations and self-reported data, indicated that *Comic Spin* was effective in supporting people with aphasia to create comic strips. Moreover, it was an enjoyable medium for doing so. A range of interesting, expressive comic strips were created which communicated a variety of fabricated and factual topics. Participants expressed humorous, joyful and dark sentiments, which overflowed into the discussions in both the in-person and online workshops.

Comic Spin provided an accessible experience for people with a range of aphasia profiles. Compared to a fully text-based tool, such as MakeWrite [31], we saw that people with a wider range of aphasia profiles were able to engage with *Comic Spin* successfully. Within both the facilitated workshops, and during extended at-home use, people with severe aphasia were able to use *Comic Spin* independently. The online workshops of study 2 also revealed that all participants felt that *Comic Spin* enabled them to make something that they could not have created without it.

The collaborative evaluation undertaken during the initial design activity and the creative workshop of study 1 identified potential refinements to *Comic Spin*, some of which were enacted prior to study 2. For example, we made changes to the user interface, added a read-aloud feature and incorporated a wider range of images and captions as suggested by participants, including non-verbal captions such as exclamation and question marks. Participants in the online workshops of study 2 made use of these additional caption choices. Clearly there are opportunities for future improvements, such as supporting the creation of comic strips with more panels, and further studies with more participants would likely reveal additional possibilities.

7.2 Constrained Creativity

The work reported here has provided further evidence that constrained creativity is a powerful approach for enabling people with aphasia to create digital content. This success was demonstrated in both the comic strips that people created and in participants' self-reports. By constraining creativity through means such as a limited set of themes and limited content within the themes, participants in the sessions were able to make creative content with ease.

The balance between constraining creativity and allowing enough freedom to tell a story sets *Comic Spin* apart from other comic creation tools. Most tools do not heavily constrain creativity beyond imposing the basic form of a comic as consisting of a series of panels containing images. In most cases, a complex interface, a multitude of options and the need for the user to provide text captions, mean that comics are challenging to create for people with aphasia. *Comic Spin* strategically limits the options for creating a comic strip in a way that forces users to think of a storyline based on the available images and captions. However, it differs from more restrictive tools because it offers choice rather than random generation. It is this *ability to iterate* through the choices in a systematic manner, so that the users can simply select 'what works', which facilitates access.

The constraints imposed by *Comic Spin* exceed that of the other technologies that we have explored with people with aphasia — MakeWrite [31], CreaTable [32] and Inker [30]. For example, all of these tools allow for more user control of the content. Users can import completely novel words into MakeWrite, but they cannot do the equivalent in *Comic Spin*: the stylized cartoon images and captions are fixed and users cannot import their own material. As the content is finite and

consists of a relatively small number of items, the number of possible permutations of a creative idea is limited, but the user should generally be able to create an aesthetically pleasing (successful) result. This has implications for the ways in which users express themselves. They must attach more meaning to that which sits around the created artefact – for instance, the story attached to the comic is often a more interesting act of expression than the comic itself.

Comic Spin also has the same levelling qualities as other technologies we have explored. For example, the constraints imposed by MakeWrite [31] mean that an expert creative writer cannot leverage their skills to the same extent as they could with a 'blank page'. The same is true for *Comic Spin*. In fact, *Comic Spin's* additional constraints mean that the content created by people of all abilities is similar – and that the self-expression in the story attached to the comic strip is perhaps more important.

7.3 Comic Forms

People with a range of aphasia profiles used *Comic Spin* effectively in the studies reported here, but in differing ways. For example, people with more severe aphasia were happy with the content provided, whereas those with milder aphasia expressed a desire for more choices. With longer use, people with more severe aphasia might also appreciate more choices. Group consensus was not clear about where this content would be sourced from. Although some people expressed the desire to put in their own content, it was clear that the simple aesthetic of the cartoon images the app provided was positively received. Another future possibility might be to extend the app to include more elaborate stories and the weaving of longer, rich digital tales (as we see in comic books). Currently, what we see produced – due to the imposed constraints – are comic strips similar to visual Hay(na)ku forms [6].

Regarding personal content, we chose not to support participants in using their own content in the studies reported here due to: 1) tensions observed in our previous work [32] when using personal content in group settings and, 2) the additional – potentially challenging – process of choosing and organising personal content for the workshops. This allowed us to explore the core constrained creativity characteristics of *Comic Spin*. This noted, we acknowledge that the integration of personal content might be desirable for some people. Future work will consider integration of personal content for individual use, and will explore how conflicts around personal content can be circumvented in group settings.

Regarding using the comic form as a means for self-expression, we found, as expected, that the comic form afforded the expression of humour as well as factual content. Humour is an important part of many shared groups, especially for those who have a shared health condition. As Sherratt and Simmons-Mackie [39] put it in their analysis of shared humour in aphasia peer groups – "*They should be called cheer groups*". Humour serves an important role in providing solidarity and togetherness. It is an important medium through which people with a range of difficulties produced by aphasia may manage their identity, diffuse tensions and communicate.

7.4 How Comic Spin was Appropriated and Enabled Self-Expression

Reflecting on content such as that shown in Figure 6, we see that people did not simply compile a comic from the predefined elements; rather they elaborated their own comic stories around these constrained choices. In this case, in a macabre and subverted way. This unexpected use of the app was similar to observations from Neate et al. [31], in which a participant appropriated their constrained writing tool to make funny, rude or odd-sounding sentences instead of what one might traditionally consider as '*creative*' writing. However, this use did vary with severity of aphasia.

We observed that *Comic Spin* allows for this humour to be expressed through comic strips in novel ways which might not be achieved so easily through the traditional forms of communication that

one would typically see in such an aphasia group. In particular, we saw a range of perspectives and interpretations of the same comics. These 'variations in interpretation' were seen in both the author and the audience of the comic strips, meaning these were both intentional and unintentional. These diverse perspectives on the comic strips created by the participants are an interesting by-product of the creative process. Speech and language therapy practitioners may find it of value to use the comic strips as a focus for discussions that elicit these diverse perspectives.

Comic Spin was designed with the vision of enabling content creation, but an unexpected by-product was creativity that went beyond the outputs (i.e. the comic strips) themselves. An interesting use of *Comic Spin* was as a medium, and indeed a provocation, to tell real-life stories. In 'The Surprise Proposal' (Figure 5), *Comic Spin* not only supported one of the participants in telling a story, but it also provided them with an opportunity to reveal something that had happened that week. This is analogous to the act of providing a 'ticket to talk' discussed by [49], and might be considered analogous to a conversational support tool (such as [24, 50]) in the way that it is used as a conversational 'prop' to scaffold conversation. It provides an opportunity to stimulate a conversation which might have never happened otherwise. Without the opportunity to use their comic strip, this participant might have found it taboo, or perhaps embarrassing, to share this piece of positive news with the entire group.

In creating their comic strips and sharing them with the entire group, participants were given a platform to approach topics that might be awkward without an icebreaker. In several cases – particularly in the online workshops and the surrounding Twitter interaction – we saw that this promoted a form of 'in group' social interaction; a form of *lingua franca* which did not extend to family members, but which was used as a means to establish in-group communication through a shared understanding of the concepts and stories presented within the comic strips. With this in mind, our future work will involve developing materials to support the leaders of aphasia groups in utilising *Comic Spin* to scaffold conversations. The establishment of this peer-to-peer engagement also suggests promising opportunities for developing previous work with mainstream tools that set out to achieve this aim [3]. Beyond this, there is merit in exploring future opportunities for digital self-expression to wider audiences outside of the aphasia group context.

7.5 In-Person and Remote Use of Comic Spin

Finally, we reflect on the participants' and researchers' experiences of the in-person and online workshops. Overall, participants were able to engage in both modes of delivery and successfully created comic strips. However, each approach had clear advantages and disadvantages (beyond the demands of the COVID-19 pandemic). A clear advantage of running the workshops online in study 2 was the convenience for participants of being at home and being able to use the app in their own time. Further, breakout rooms meant that it was possible to work with smaller subsets of participants on a specific topic or challenge that they were experiencing.

However, running the workshops online also meant it was more challenging for the researchers to gauge the experiences and progress of the participants. When participants are engaged in any novel activity, it is useful for researchers to quickly 'check in' by looking at their progress, or checking for 'blank faces'. These checks often rely on the affordances of a physical space - i.e. being able to quickly look over someone's shoulder to see what is happening. Further, in the in-person workshop, participants were able to support each other by 'shoulder surfing' but the online environment was not this. Finally, and not surprisingly, it was more difficult to resolve technical issues online. Participants would hold their tablets up to the Zoom webcam to show the problem to the facilitator and this was especially challenging for participants who had limited use of one hand.

8 CONCLUSION

This work has made two main contributions. Firstly, we have created a tool that supports the creation of comic strips by people with aphasia. *Comic Spin* was designed around the idea of constraints as a way of enabling creativity and was built through a Design Thinking approach involving collaborative activities with expert proxies, designers and people with aphasia to ensure that it was accessible. Secondly, through two studies, we explored the effectiveness of *Comic Spin* in enabling people to create comic strips and investigated how *Comic Spin* was used for self-expression. Findings not only offer additional evidence to support previous work [31, 32] that computationally-supported constrained creativity can enable people with aphasia to create digital content, but go beyond this to reveal that creating comic strips can be a scaffold for broader self-expression. Participants in the studies were able to create interesting, funny and auto-biographical content that they would not have been able to produce otherwise, and they used this to create and share factual and fictional stories.

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