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Naming therapy via SANTA: measuring the effectiveness of facilitation naming therapy via a web-based app

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O L L S C O I L L U I M N I G H

Naming Therapy via SANTA

Measuring the effectiveness of facilitation naming therapy via a web-based app

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Authors Declaration

"I certify that this project report is entirely my own work and that it has not been submitted for any other academic award or part thereof, at this or any other educational institution. Where use has been made of the work of other people it has been fully acknowledged and fully referenced."

Signature:

Date:

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1. Abstract

Background: Word retrieval difficulty (anomia) is almost universal in aphasias of all types. Most naming therapy however is only effective for the treated words (Best *et al* 2002; Nickels 2002; Wisenburn and Mahoney 2009). Size and usefulness of vocabulary is therefore paramount in therapy. Recent studies have found that facilitation therapy is effective at treating large sets of words (Kelly and Franklin 2012). Although traditional service delivery models treat small sets of words, this could be easily increased using software applications (apps). However most naming apps contain a small, fixed vocabulary of words or require adaptation by the therapist.

Objectives: This study aims to investigate the following: (i) Will people with aphasia (PWA) use a self-administered, naming therapy app (SANTA); and (ii) Is facilitation naming therapy effective in improving naming performance in PWA when self-administered via a customisable, web-based app (SANTA)?

Methods: SANTA allows PWA to self-select items and use facilitation therapy for themselves. They touch the picture and the app produces the spoken word for them to repeat. Six participants with chronic anomia post CVA piloted the app. Naming abilities were tested at follow up on the Boston naming test (control measure) and the treatment sets (words added to the app by participants). Items of a frequency of less than 10 in both sets were compared.

Results: Participants MJ, CM and BA showed the highest usage of the app during and post intervention. These participants had an average of 122 words and 821 clicks each whereas participants CV, NA and PM averaged 63 words and 232 clicks. All participants (with the exception of NA) were more accurate on treated sets, but only MJ, CM and BA showed a significant difference.

Conclusions: Naming on treated items improved for three participants. When usage data was examined, these three participants used the app the most. The findings of this study suggest that self-administered facilitation naming therapy via a web-based app is feasible and effective.

2. Introduction

Word retrieval difficulty (anomia) is almost universal in aphasias of all types (Goodglass & Wingfield, 1997; Martin 2013), with proper names (e.g. of family and friends) being a particularly vulnerable category (Saetti *et al* 1999; Robson *et al* 2004). Almost all persons with aphasia (PWA) therefore have some degree of difficulty finding the right words. This can have a significant impact on their ability to communicate with those around them and may limit their participation in many activities of daily living and in social networks (Hilari and Northcott 2006). As well as improving communicative competency, improving word retrieval can therefore have a positive psychosocial impact on the PWA by reducing frustration and improving participation. Numerous studies have been conducted in this important area of research to determine the underlying deficits and establish effective therapies (Wisenburn and Mahoney 2009).

Devising individualised treatment programmes with appropriate, relevant and sufficient stimuli and practice is a challenging task for any clinician. This can be facilitated by the use of computer technology. In recent years, with the advent of smart technology and increased internet access, it is becoming more and more commonplace to use computer-assisted therapy (CAT). This study investigates delivery of naming therapy via computerised tasks, specifically a web-based software application (app). Rehabilitation of anomia is a complex and lengthy but worthwhile process (van de Sandt Koenderman 2011). To understand how technology like web-based apps can be of benefit, it is important to first outline intervention approaches for anomia and the challenges which lie therein. The use of computer technology in relation to impairment based therapy for PWA will then be discussed. This overview is not intended as a complete review of the field. It will present some of the research to highlight ongoing development in the area and evaluate a selection of available software applications for naming therapy in terms evidence base and accessibility.

2.1 *Therapies for naming*

There is a wealth of research on therapy for anomia. The consensus is that the effectiveness of word finding treatments is well established (Nickels 2002; Wisenburn and Mahoney 2009). Most of the research looks at semantic versus phonological deficits and semantic versus phonological tasks. Some research suggests matching the task to the underlying deficit (Hillis 1989). However many others suggest that this is not necessarily the best

approach (Lorenz and Siegler 2009) as both types of therapy appear to be successful for both levels of deficit.

One therapy for anomia is semantic feature analysis (SFA): the PWA is provided with a picture, asked to name it, and then encouraged to describe it, prompted by e.g. “is used for...” to generate semantic features relating to group, properties, use, action, location, and association (Boyle & Coelho 1995; Coelho, McHugh & Boyle 2000; Boyle 2004; 2010). Very few studies have examined the effects of semantic treatments in a ‘pure’ sense i.e. where no word form is provided. Nickels (2002) argued that the treatment and generalisation effects seen with “semantic” therapy may be mainly down to the phonological provision of the word or at least the combination effect of both.

It has since been shown (Howard *et al* 2006; Wisenburn and Mahoney 2009) that individuals may benefit more from a phonological approach or a combined approach. Much of the prominent research since the 1980s (Howard *et al* 1985; Howard *et al* 2006) has shown that use of facilitation strategies (i.e. simple techniques such as sound cues, spoken word to picture matching or repetition with the picture) increase successful naming performance. Naming facilitation therapy can be semantically or phonologically focused. Howard *et al* (1985) found a significant improvement in naming of target words when using both ‘semantic’ (spoken word to picture matching with semantic distractors), and phonological tasks (repeating the picture name). In a later study, Howard *et al* (2006) state that facilitation works via priming the link between meaning and word form. The added benefit of facilitation therapy lies in its simplicity, allowing for ease of implementation.

2.2 *The generalisation dilemma*

It is widely accepted that most naming therapy is only effective for the treated words and therefore generalisation to untreated words is not expected (Best *et al* 2002; Nickels 2002; Wisenburn and Mahoney 2009). Treatment size and intensity may therefore be important in achieving meaningful outcomes. Bhogal *et al* (2003), and other studies (Basso, 2003; Lincoln *et al* 1998; Salter *et al* 2007) advise a minimum intensity of at least two to three hours per week, up to eight hours. However, the current care pathway for PWA is less than ideal for fostering this. Typical intervention periods will treat 30-80 words (Snell *et al* 2010). When we consider that typical vocabularies consist of thousands of words and that

generalisation is, at best, limited, it is clear that the PWA is already at a disadvantage. Although therapists may try to ensure the treated words are functional (Renvall *et al* 2013a and 2013b), it may not be enough to make a meaningful difference with these constraints in mind (Rose 2013).

Due to the nature of word finding as an access issue rather than a complete 'loss' of the words, (Howard *et al* 2006) there should be no limit to the amount of words which can be treated using facilitation therapy. Recent research (Kelly and Franklin 2012) has shown that there was no difficulty in treating sets of up to 500 words. However it is unlikely that current care pathways would allow for the treating of such a number of words (Katz *et al* 2000), and even 500 words is a relatively small vocabulary. There is clearly a need for better service delivery for this population in order to provide adequate care.

2.3 A solution to the dilemma?

One such way to address the problem is to use computer-based self-administered therapy to increase size, intensity and/or duration (Katz 2010; Petheram and Enderby 2008), either as an adjunct to traditional methods or as a means to continue therapy exercises independently. Technology use has dramatically increased in recent years, with over 70% of Europeans now online (www.internetworldstats.com) and most people owning at least one personal device. Theodorus (2012) makes the strong point that the convergence of several factors mean SLT practice will, and must, diversify and innovate by embracing and utilising technology. This next section gives: a) a brief overview of the evidence for using computerised interventions; and b) reviews and evaluates a number of apps available and studies which examine their use in therapy.

2.4 Computer-based naming therapy

A wealth of studies have looked at aphasia therapy delivered via computers. All have shown it to be both feasible and clinically beneficial. Studies of self-administered therapy for aphasia have, to date, been limited to descriptive case series with only three reported randomised control trials (Palmer *et al* 2012; Cherney 2010; Katz and Wertz 1997). Although not fully powered, these studies indicate potential effectiveness of computer therapy. Bodies such as the American Speech, Language and Hearing Association (ASHA) and the Royal College of Speech and Language Therapists (RCSLT) conclude there is "Level 1/A

evidence” for using computer-based treatment in aphasia therapy (Salter *et al* 2013; Taylor-Goh 2005; Management of Stroke Rehabilitation Working Group 2010).

There is a distinction in the literature between CAT (computer assisted treatment) and COT (computer only treatment). Laganaro *et al* (2003) showed unsupervised computer-assisted treatment (CAT) to be efficacious with a group of four patients with chronic anomia however there is less research on COT (i.e. where the client administers the therapy independently, in as much as possible). Much of the research agrees that some level of SLT involvement is needed.

2.4.1 Apps/Programs which have been tested in empirical research studies

A simple Google search for ‘aphasia apps’ yielded over 232,000 results however many of these are not evidence-based. The following section discusses a selection of evidence based tools.

Bruce and Howard (1987) developed a computer-generated treatment, which converted letters to sounds to provide self-generated cues. Five PWA who were responsive to initial phoneme/letter cues were treated for four sessions and were trained to use the cueing aid to generate phonemic cues. All five demonstrated improvement in naming treated and untreated items with the aid. One no longer needed the aid. Best, Howard, Bruce, and Gatehouse (1997) replicated this with a patient with limited letter knowledge as well as severe deficits in word retrieval - once a week for five weeks. Highly significant and lasting improvement (over 15 months) was seen for both treated and untreated items without the use of the aid and were evident in spontaneous speech.

Van Mourick and Van de Standt-Koenderman (1992) developed Multicue, a program which offered a variety of cueing options (semantic and phonological) to enable users establish successful word-finding strategies to access words. In a follow-up study (Doesborgh *et al* 2004), 18 individuals with aphasia were randomised to 10-11 hours of Multicue (n = 8) or no treatment (n = 10). Improvement in naming of untreated items was significant only for the treated group, indicating a beneficial effect of treatment.

Additional evidence that computer-assisted treatment is beneficial and that independent work on the computer can be effective comes from a study by Fink *et al* (2001; 2002a). This study involved a computerised therapy system called MossTalk Words, which was designed

to be used in the clinical setting as well as by patients working independently. The cued naming module is based on cueing principles and facilitation techniques. Fink *et al* (2005) further expanded on this research showing promising results. Many others followed, applying some different criteria while still maintaining positive results: Ramsberger and Marie (2007) looked at self-administration of the Cued Naming Module; and Jokel *et al* (2006; 2007; and 2009) successfully applied the programme to patients with semantic dementia and primary progressive aphasia.

Mortley, Enderby and colleagues (Mortley *et al* 2003; Mortley, Wade & Enderby 2004; Mortley *et al* 2004) developed StepByStep which includes a wide range of structured exercises including Word repetition and Word naming. The home version is priced at £250 (+VAT) and a Clinician's license = £550 + VAT. Following a successful pilot study (Palmer *et al* 2012), a large pragmatic randomised control trial is currently under way in the UK (under the Big CACTUS program) to test the effectiveness of this self-managed computer intervention for chronic anomia (post therapy, with monthly face-to-face support from a volunteer), versus that of traditional face to face clinical treatment only.

2.4.2 Apps based on evidence-based naming therapies

Lingraphica®, The Aphasia Company™ have SmallTalk™ - a family of free therapy practice apps - and TalkPath™ Therapy - a suite of online and app based therapy tasks including word repetition (facilitation therapy) and confrontation naming practice. Clinicians are required create customised therapy plans for clients and monitor progress so this does not allow for independence or adding your own words.

MoreSpeech is a new offering from Bungalow software, the makers of Sentence Shaper (Linebarger *et al* 2004; 2007; McCall *et al* 2008). It is based on established facilitation principles and provides therapy exercises for a range of language and speech difficulties. It costs \$24 per month and it appears to have a fixed vocabulary.

Neuro Hero's (www.neurohero.com) 'Talk Around It' is an Irish suite of apps aimed at people with word finding difficulties. It is based on the principles of SFA (Boyle 2010; Wambaugh *et al* 2014) and each app represents a category (e.g. 'Talk Around It Nature'). It costs €10.99-19.99 per category and comes with a fixed set of words.

Naming TherAppy has been developed by Megan Sutton, a speech and language pathologist. Although there is no specific research evidence for the app itself as a therapy tool, the content is based on evidence-based technique known as cued naming and SFA. The 'Naming Practice' module of Naming TherAppy provides 6 steps of cueing, arranged in a hierarchy from least to most helpful: a mix of semantic, orthographic and phonemic (first sound and word repetition). The client or clinician can choose the order that works best (based on cueing strategy research by Linebaugh *et al* 2005 and Abel *et al* 2005). Another module of the app called 'Describe', also uses principles of SFA (Boyle 2010, Wambaugh *et al* 2014) and phonological components analysis or PCA (Leonard *et al* 2008; van Hees, 2013). The app has a vocabulary bank from which you can customise a set of targets to work on, however this is still limited to 700 words. They have recently updated the app to allow you add your own words, however it is not straightforward and the 'naming test' feature is still limited to a set of 30 words. There is a free version however this is just a trial with only 5 pictures, so you need to purchase the premium version which costs \$24.99.

The Tavistock trust (www.aphasiasoftwarefinder.org) has more information on available apps.

2.4.3 Summary and synthesis

The apps above draw on solid evidence based therapy however there are relatively few apps available that are empirically tested. There is a paucity of research comparing computerised self-administered naming therapy to usual therapist-only intervention, however a pragmatic RCT is currently under way following from a pilot RCT (Palmer *et al* 2012). In general, there are few studies looking at self-administered therapy using apps. In terms of the current offerings, accessibility is restricted due to a lack of open platform (web based) apps and the cost involved. Most are also limited in terms of customisability. There are some apps where you can add words but not easily, and generally not without the help of a therapist.

2.5 Purpose of this study

There is a need for evidence based apps that are accessible, customisable, functionally useful and also effective in improving naming ability and quality of life for PWA. This study investigated outcomes of an initial pilot of SANTA (Self-Administered Naming Therapy for

Aphasia) - a web-based app - with a small group of PWA. The research hopes to answer the following: (i) Will people with aphasia (PWA) use this app?; (ii) Is facilitation naming therapy effective in improving naming performance in PWA when self-administered via a customisable, web-based app (SANTA)?

3. Method

3.1 Design

This is a detailed pilot study to assess the usefulness and usability of the app. A case series design was employed where participant's scores will be analysed individually, using an item-specific control design, with untreated words serving as control items (Franklin, 1997). This design was chosen because it may be that different clients show a different pattern of response. Electronic data from the app will also be examined to ascertain the usage levels of each participant, thus naming performance can be compared with amount of practice. It is hypothesized that pictures of words on the app will be named significantly more often than words that do not appear on the app. In addition, a thematic analysis will be used to analyse participant interviews (see Knox and Franklin 2015; Leahy and Franklin 2015).

3.2 Participants

3.2.1 Recruitment

Participants were sourced from HSE clinics. Community HSE therapists were contacted by a gatekeeper and referrals were received. Participants were then selected through judgement sampling. Ethical approval was obtained from the University of Limerick Research Ethics Committee for eight subjects: two for development of the app and six for the pilot study and follow up. The two participants involved in the initial development phase decided to continue with the app, and so the current pilot study involved six participants with anomia. Informed consent was obtained from each participant using aphasia friendly forms (see appendix 1).

3.2.2 Selection Criteria

Participants were required to (a) be aphasic following CVA, (b) be at least six months post CVA, to reduce the possibility of spontaneous improvement, (c) be experiencing word finding difficulties, (d) have no known cognitive impairment which could compromise

understanding of their participation in the research, (e) be in reasonable health, (f) be native English speakers (as the app is in English), (g) not be receiving any other speech and language intervention during the study, and (h) be able to repeat 80% nouns on a repetition subtest of Comprehensive Aphasia Test to rule out phonological assembly deficits. CV did not meet criteria (h) - 53%; and NA did not meet criteria (b) - five months. However both were included in the study, with appropriate caution taken when interpreting the results.

3.2.3 Pre therapy Assessment

Auditory and written comprehension and repetition abilities were examined using elements of the Comprehensive Aphasia Test (CAT) (Swinburn, Porter, & Howard 2005): 'Comprehension of Spoken Words', 'Comprehension of Written Words' and 'Repetition of Words'. The Boston Naming Test or BNT (Kaplan, Goodglass & Weintraub 2001) was administered pre therapy to assess the severity of anomia.

Table 1. Participant data and pre therapy assessment

Participant	Age	Gender	Time post CVA (months)	CAT Subtests		
				Comprehension		Repetition
				Spoken Words	Written Words	Real Words
MJ	89	M	38	29/30	22/30	28/32
CM	70	F	13	20/30	22/30	30/32
BA	75	F	21	22/30	27/30	26/32
CV	72	M	70	21/30	19/30	17/32
NA	68	M	5	23/30	24/30	30/32
PM	65	M	46	26/30	28/30	30/32

MJ was 89 years old at the time this study began. He was 38 months post onset of aphasia secondary to a CVA which occurred during a stenting procedure of his right carotid artery. He had retired after a career as a building contractor, however up until the time of his stroke he was still actively involved in the family business including the keeping of horses. Single word auditory comprehension and repetition abilities were within normal limits, however written word comprehension was below average (see table 1). He had a severe naming difficulty, indicated by his BNT score of 12 out of 60 items correct.

At the beginning of the study, CM was 70 years old. She had suffered two CVAs prior to the study, 19 and 13 months beforehand respectively. Prior to this, she had worked as an exam invigilator at a university. She continues to be active in her local bridge club, teaching new members and has a keen interest in music. Auditory and written comprehension of single words were below average, however word repetition abilities were within normal limits (see table 1). Her severe anomia was reflected in her BNT score of 11 out of 60 items correct.

BA was 75 years of age at the beginning of this study having suffered a CVA 21 months previous. She had retired prior to having her stroke from her job as a rep for a cigarette company. She lives alone and enjoys gardening and sport. Single written word comprehension was within normal limits. Spoken word comprehension and repetition abilities were below average but repetition scores fell within the accepted range ($\geq 80\%$) for the study requirements (see table 1). Her severe anomia was reflected in her BNT result of 23 out of 60 items correct.

CV was 72 years old at the time this study began. He had suffered a right MCA infarct 70 months prior to beginning the study resulting in hemiplegia, aphasia and dysarthria. Prior to his stroke, he had recently retired from the department of agriculture and had been very active with many hobbies. Single word comprehension and repetition abilities were below average (see table 1). CV had a profound anomia, answering 6 of the 60 BNT items correctly.

At the time this study began, NA was 68 years old. Five months before the study began, he suffered a CVA, resulting in aphasia. He was the only participant residing in a nursing home at the time of the study. He previously worked in many fields including as a security guard. He has a keen interest in reading and music, particularly classical. Single word comprehension was below average. However, repetition abilities were within normal limits (see table 1). On the BNT, a score of 38 out of 60 items correct indicated a moderate to severe anomia.

PM, a retired science teacher was 65 when the study began, having suffered a CVA 46 months before. He had a keen interest in botany and had completed a master's degree in same at 53. He enjoys following Gaelic football and hurling, and reading. Single word comprehension and repetition abilities were within normal limits (see table 1). PM had moderate to severe anomia with 35 out of 60 items named correctly on the BNT.

3.3 Materials and stimuli

SANTA is a customisable web-based therapy app, developed during the design phase of this project. PWA or their family/friends can add categories and items as and when needed. When adding an item, a category is chosen, the user types the word and hits search. The app sends a query to Google which generates and displays a number of suitable images for that word. The user is able to select their preferred picture and can also edit the word as needed. Audio recordings of the spoken words are automatically generated by text-to-speech software and are stored on the back-end. When the picture is touched, the app produces the spoken word. Participants were given smart phones with internet access with which to use the app however three opted to use a tablet as they preferred a bigger display.

3.4 Treatment procedure and data collection

The six participants with chronic anomia post CVA piloted the SANTA app. Participants were visited weekly by a research assistant (RA) who assisted the PWA and their family/friend with setting up the app on the devices, training them to use the app and reporting any problems to the app designer for troubleshooting.

All items were self-selected and added to the app by participants or family/friends. These items were treated through self-administered facilitation therapy (i.e. the participant practiced the items added by touching the picture and repeating the spoken word). Participants were free to choose how much they practiced and how many words to add, but had the support of weekly visits from the RA.

Naming abilities were re-tested using the BNT post intervention and at follow-up. This was used as a control set to assess change in untreated items over time.

The treatment sets (words added to the app by participants) were also tested at follow-up. Up to 120 words added by each participant to the app were to be selected post hoc as the treated sets. No participant had added over 120 items at that time so all items were included.

Usage data was gathered electronically by the programmed software. A unique identifier and a timestamp assigned to each action (e.g. words being selected, categories being added) was transmitted and stored on the back-end.

3.5 *Analysis Procedures*

3.5.1 **App use**

Usage data was examined to assess the level of usage per participant (i.e. number of clicks, categories and words, and patterns of usage when support present vs absent). Descriptive statistics were used to summarize this data. RA visit reports were also examined to report on whether participants were able to use the app.

3.5.2 **Naming**

It was hypothesised that there would be no significant change in untreated items (BNT) over the three measurement times and that naming accuracy would be higher on treated (SANTA) items. The BNT was therefore used as a control measure and items analyses were carried out using Cochran Q Tests and McNemar tests for post hoc analyses to establish any changes in naming over time.

Both sets (BNT and SANTA lemmas for each participant) were then analysed for frequency with ratings obtained from the CELEX database (Baayen *et al* 1995; Max Planck Institute 2001). A cut-off of <10 (lemma frequency per million) was selected to allow comparison of performance on low frequency words across treated and untreated sets at follow-up. Of all variables affecting naming accuracy, word frequency appears to be one of the most stable and replicable of results from studies of groups of aphasic patients, with some studies finding a positive linear relationship between the two (Nickels and Howard 1994). Therefore in this case, higher accuracy in treated sets should be attributed to therapy effect and not to differences in frequency between sets. Statistical analyses were carried out using Fisher exact tests to test the difference between these two sets for significance.

4. **Results**

4.1 *Overall Results*

Usage: As seen in table 2 below, participants MJ, CM and BA showed the highest usage of the app during and post intervention. They had an average of 122 words and 821 clicks each whereas participants CV, NA and PM averaged 63 words and 232 clicks. All participants were able to use the app following training. Most required some level of assistance for adding

items. This was always envisaged, hence the training of a family member or friend, however one participant did require extra help when practicing items.

Table 2. App usage by participant

Participant	No. of categories	No. of words	No. of naming clicks		
			RA times	Other times	Total
MJ	10	102	139	861	1000
CM	10	122	240	212	452
BA	13	142	79	933	1012
CV	7	31	36	197	233
NA	6	44	102	31	133
PM	10	116	103	227	330

Naming: Some significant change was shown on control items for participants MJ, CM, CV and PM over the three measurement times (see figures 2 to 7). However when removing the post intervention result, there is no significant difference for all but one participant (CV).

All participants (with the exception of NA) were more accurate on treated sets at follow-up, but only participants MJ, CM and BA showed a significant difference (see Fig. 1 below).

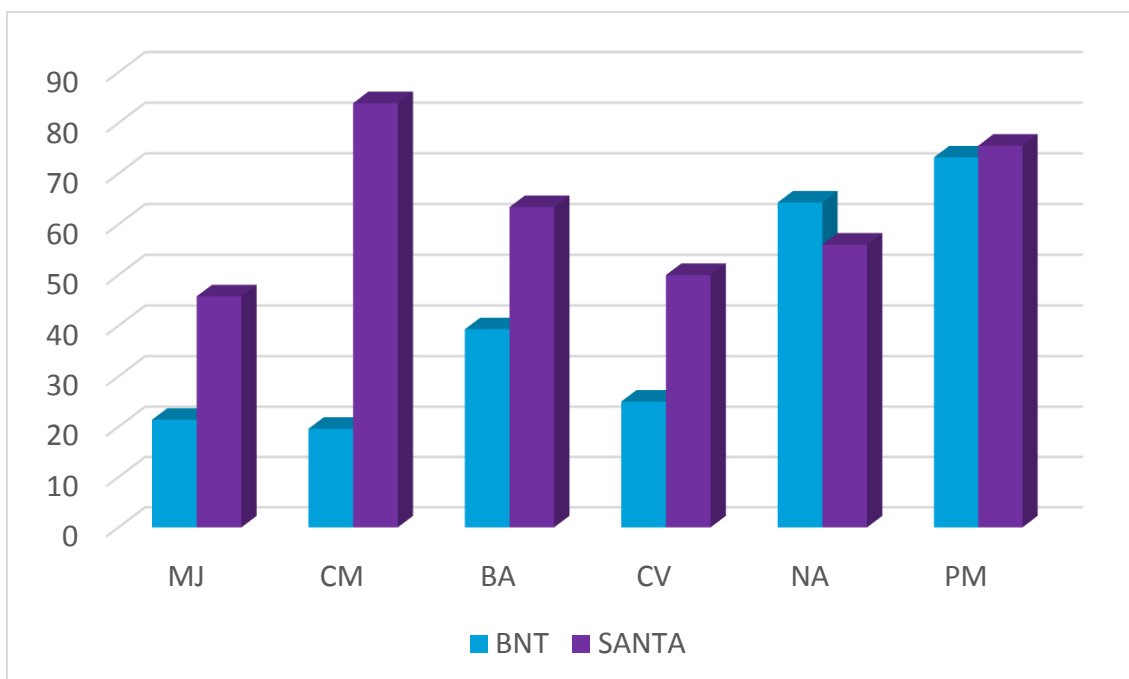


Figure 1. Treated vs untreated sets at follow-up (controlled for frequency)

4.2 Individual Results

4.2.1 MJ

MJ was well able to use app independently after initial training but continued to require someone to add items. Generally he did not wait for the spoken word before practicing the item. He added a total of 10 categories (including 'Farm', 'Car', 'Family', 'Home', 'Kitchen', 'Living Room', 'Numbers' and 'Travel') and 102 words and had the second highest number of clicks of all participants at 1000. He used the app regularly and in fact used it more often when alone and after the RA's visits had ceased.

Cochrane Q tests showed some significant difference ($p = 0.015$) in performance over the three testing times for control items (BNT) with a Cochran Q (2) overall score of 8.4. Looking more closely however, McNemar tests only showed a significant difference between BNT 1 and BNT 2.

Naming performance on the treated set was more accurate than the untreated set at follow-up (see Fig. 1). Fisher exact tests showed this as significant (FE $z = 2.12$, $p = 0.034$).

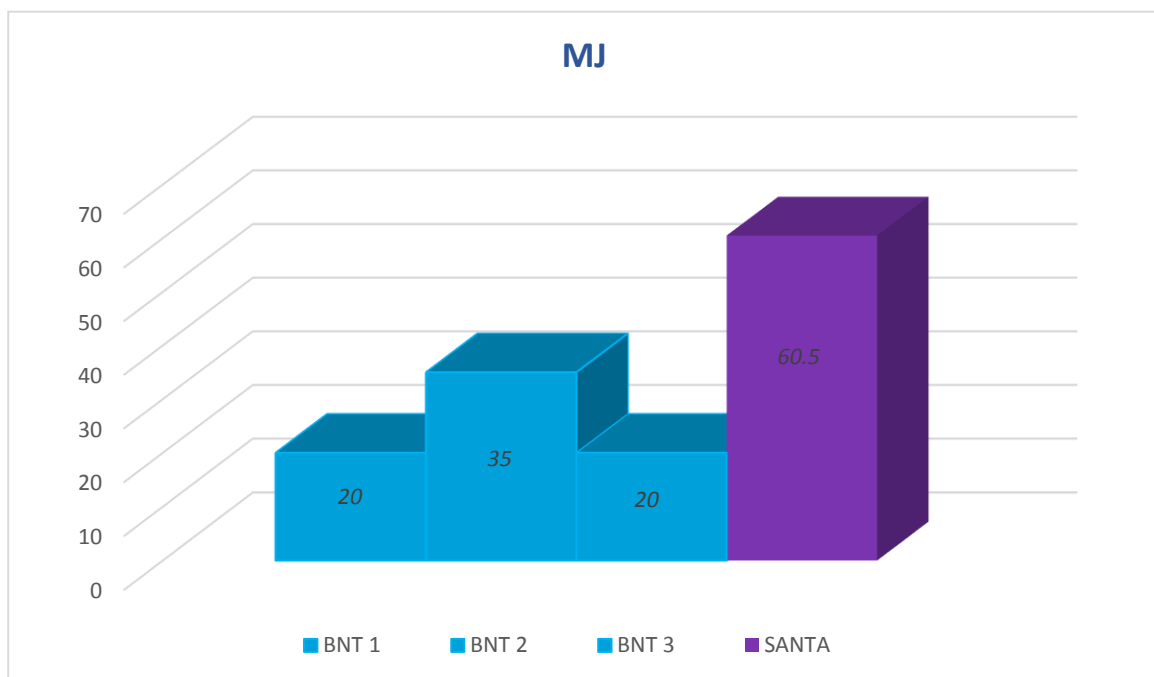


Figure 2. Naming performance over time for MJ: treated vs untreated

4.2.2 CM

CM was able to use the app independently however sometimes did forget where the 'back' button was located for navigation. She required assistance to add new items. She tended

not to wait for the app to produce the spoken word before practicing. She added a total of 10 categories (including 'Bakery', 'Bridge board games', 'Christmas', 'Clothes & Accessories', 'Cookery', 'Dogs', 'Meal table', and 'Music') and 122 words and had the third highest number of clicks of all participants at 452. She used the app more when the RA was present.

A significant difference in performance was shown over the three testing times for control items (BNT) using a Cochran Q test (Q (2) overall score = 10.13; p = 0.006). Looking more closely however, McNemar tests only showed a significant difference between BNT 1 and BNT 2 (p = 0.002) and not between BNT 2 and BNT 3 or between BNT 1 and BNT 3.

Fisher exact tests showed her naming performance on the treated set was significantly more accurate than the untreated set at follow-up (FE z = 6.77, p = <0.001) (see Fig. 1).

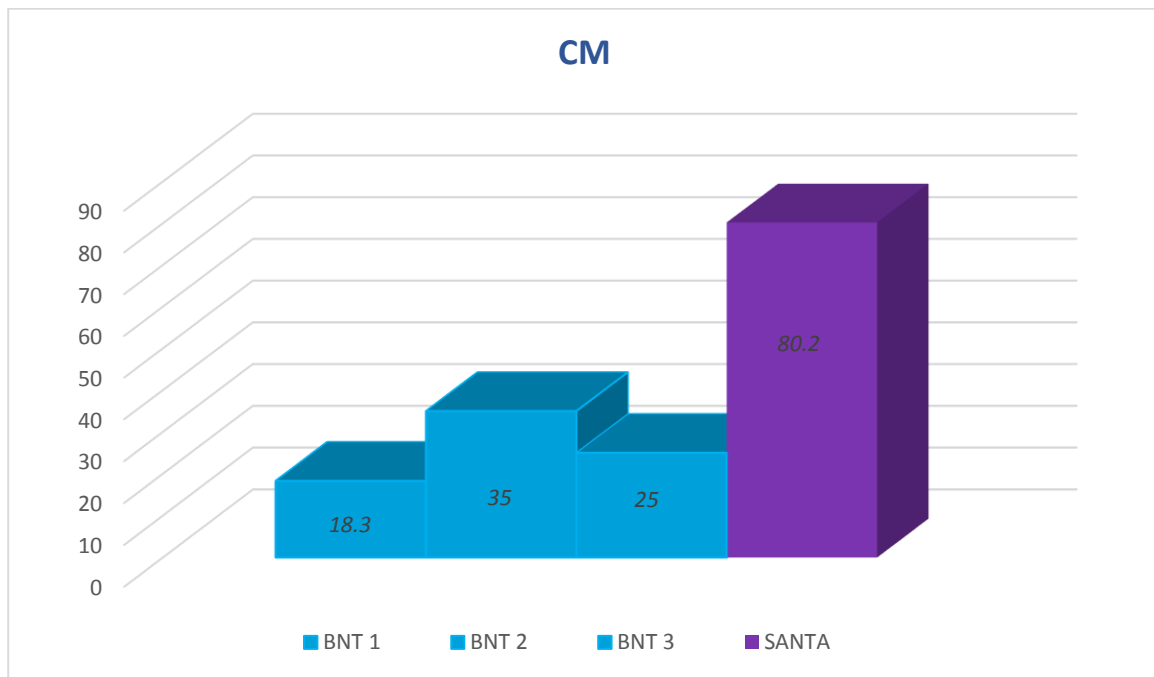


Figure 3. Naming performance over time for CM: treated vs untreated

4.2.3 BA

BA was able to use the app independently but needed help adding items as she found the keypad too small. She originally had difficulty with scrolling and tapping (tapping too hard) however this improved somewhat with practice. She regularly tapped outside the app, inadvertently leaving SANTA and needed reminders to use the 'back' button to change categories. She usually did not wait for the app to produce the spoken word before practicing. Out of the six participants, she used the app the most, adding 142 words and 13

categories (including 'Bakery', 'Bathroom', 'Bedroom', 'Breakfasts', 'Christmas', 'Dinner time', 'Kitchen', 'Living room', 'Meats', 'Seaside' and 'Weather') and had 1012 item clicks. She used the app far more when the RA was not present and after visits had ceased.

No significant difference in performance was shown over the three testing times for control items (BNT) using a Cochran Q test.

Her naming performance on the treated set was significantly more accurate than the untreated set at follow-up (see Fig. 1) as shown by Fisher Exact test (FE $z = 2.13$, $p = 0.033$).

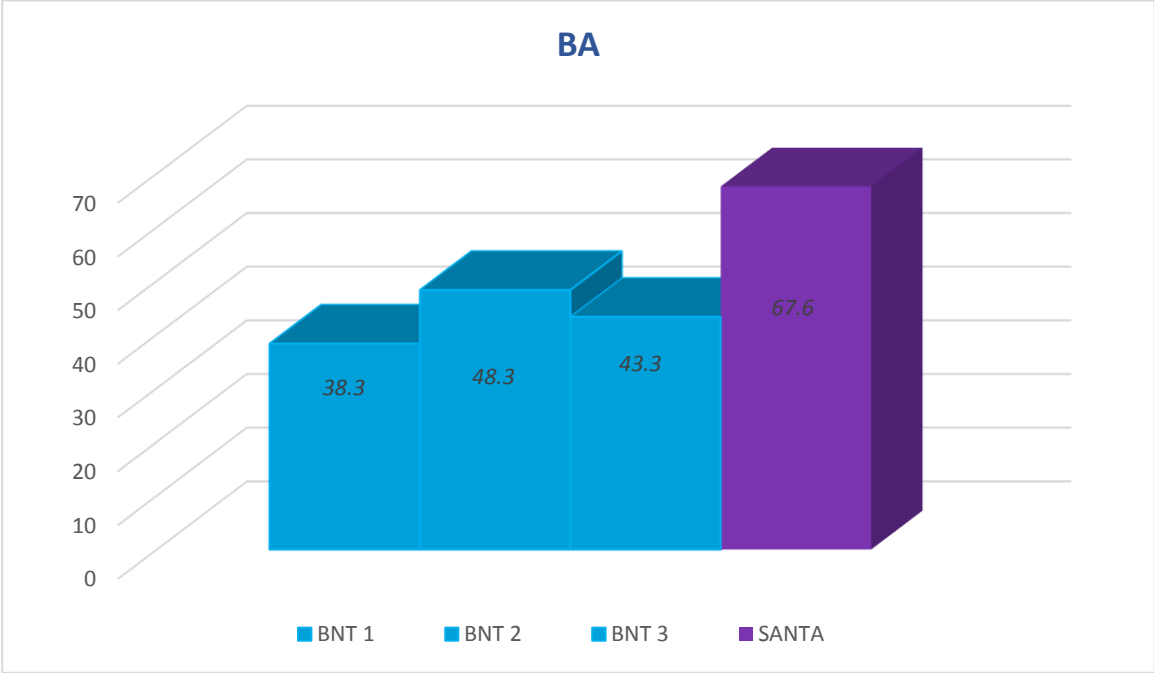


Figure 4. Naming performance over time for BA: treated vs untreated

4.2.4 CV

CV was able to use the app with a high level of assistance. Although he improved a little over the course of the study, he still found it difficult to select items (poor coordination and tapping too hard). He sometimes did not wait for the app to produce the spoken word before practicing. He had a flaccid dysarthria resulting in low intelligibility and the RA reported it difficult to know whether CV could successfully repeat the words. Out of the six participants, he added the least items (31 words) over 7 categories ('Bed', 'Fire', 'Hurling', 'Irish Farming', 'Irish Music', 'Mealtime' and 'Remote') and had 133 item clicks. He used the app more when the RA was not present.

A significant difference in performance was shown over measurement times for control items (BNT) using a Cochran Q test (Q (2) overall score = 12.93; $p = 0.002$). BNT 3 was significantly more accurate, with McNemar tests showing a significant difference between BNT 1 and 3 and between BNT 2 and 3 ($p = 0.039$) but not between BNT 1 and BNT 2.

Performance on treated items appeared much higher than on untreated when looking at percentage correct (see Fig 1.), however Fisher exact tests showed the difference was not significant due to the small number of items in the treated set.

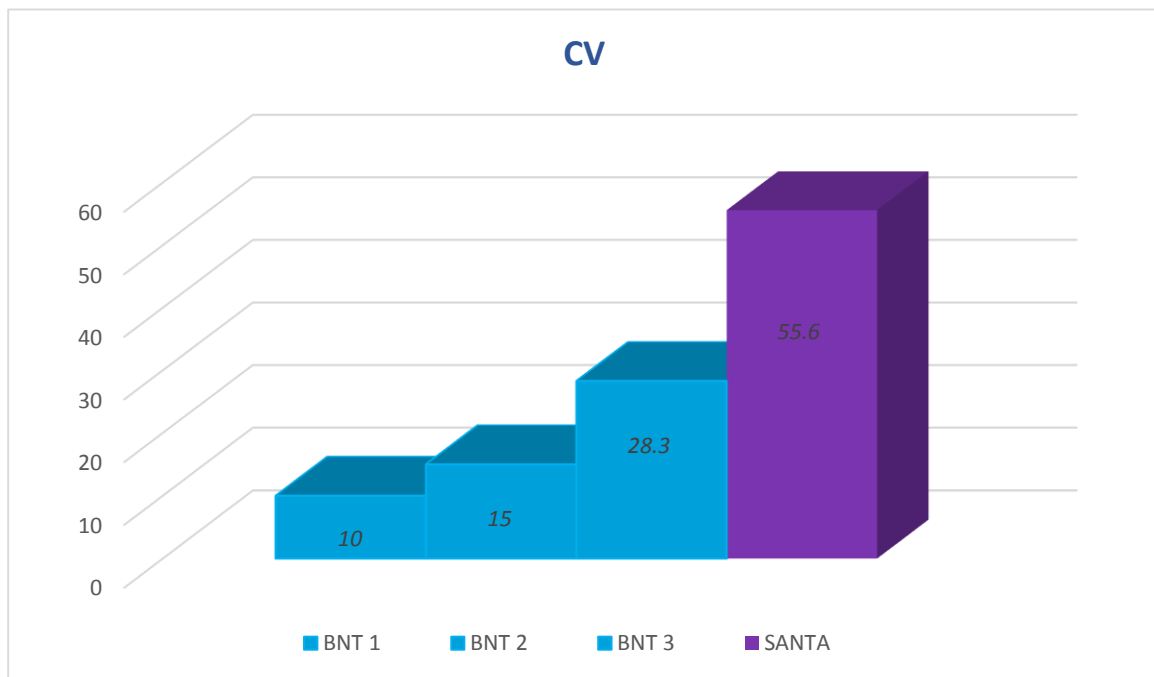


Figure 5. Naming performance over time for CV: treated vs untreated

4.2.5 NA

NA was able to use the app but sometimes required assistance (e.g. scrolling, unable to go back, accidentally pressing home button and exiting app - then finds difficult to get back in). He generally used the app with a carer in the nursing home who also helped him to add items. He tended not to wait for the app to produce the word before practicing. Out of the six participants, he used the app the least (133 item clicks). He added a total of 6 categories ('Breakfast', 'Food', 'History', 'Music', 'Shopping' and 'Sport') and 44 words. He mostly used the app when the RA was present. NA lost the device twice and after the second time (post intervention) a replacement phone was not issued.

No significant difference in performance was shown over the three testing times for control items (BNT) using a Cochran Q test.

Naming performance on the treated set was slightly less accurate than the untreated set at follow-up (see Fig. 1). Fisher Exact tests showed the difference was not significant.

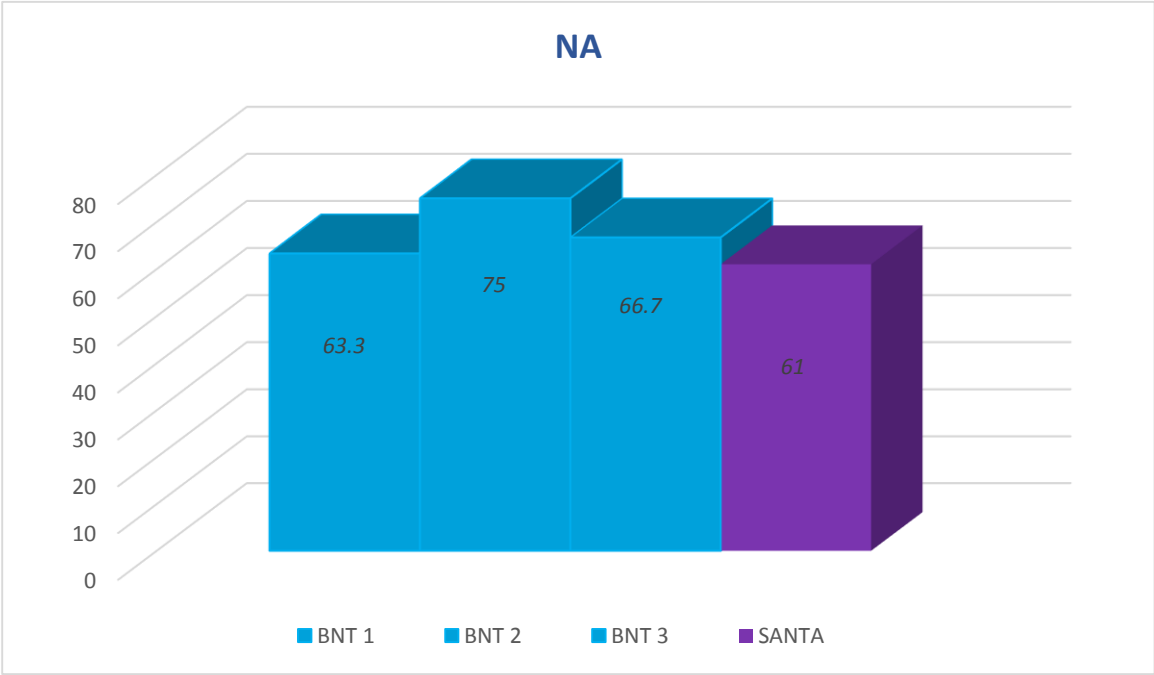


Figure 6. Naming performance over time for NA: treated vs untreated

4.2.6 PM

Initially PM had some difficulty in remembering to use the back button, inadvertently adding words to incorrect categories. Following training however he was able to use app very well independently without any issues, including adding items. He tended not to wait for the app to produce the word before practicing. He added 10 categories (including 'Appliances', 'Baking', 'Books', 'Cars', 'Food', 'Gardening', 'Horse racing', 'Hurling' and 'Walking') and 116 words, with a total of 330 item clicks. He mostly used the app when the RA was present and did not continue to use the app after her last visit.

A significant difference in performance was shown over the three testing times for control items (BNT) using a Cochran Q test (Q (2) overall score = 9.58; p = 0.008). Looking more closely however, McNemar tests did not show a significant between BNT 1 and BNT 3 but did between BNT 1 and BNT 2 (p = 0.023) and BNT 2 and BNT 3.

Naming accuracy on the treated set was very slightly higher than untreated items (see Fig. 1) but was not significant as per the Fisher Exact test.

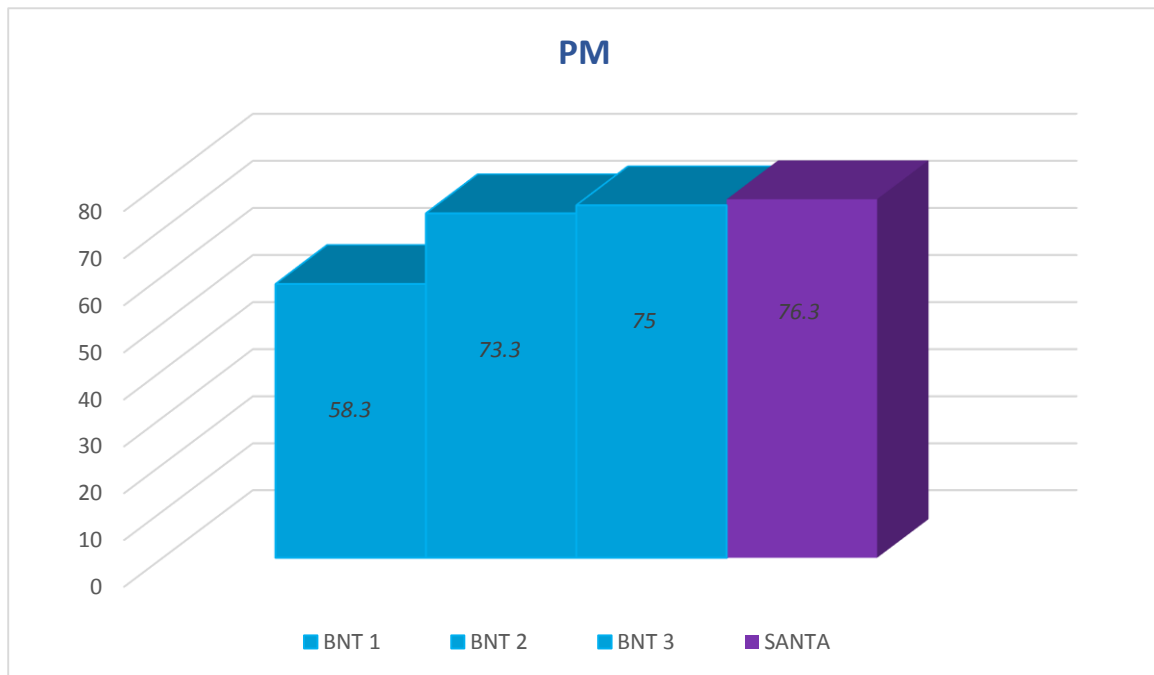


Figure 7. Naming performance over time for PM: treated vs untreated

5. Discussion

5.1 Will people with aphasia use this app?

The results presented are promising from several perspectives. Despite the participants in this study having had very limited prior experience with smartphones and tablets, all were able to quickly learn to operate both the hardware and the app and to carry out treatment procedures, with just one participant requiring extra assistance. It is important to remember that with less therapist contact and support, maintenance of motivation may be affected, since therapists often are a source of positive reinforcement and encouragement. This may have been a factor with some participants more than others (e.g. CM and NA). Despite this, all participants used the app, both when clinician support was present and when not. All were able to use the app but required varying degrees of support and all participants added functional and personal vocabulary to their apps.

All six participants expressed an interest in keeping the app for continued use and would recommend it to others with naming difficulties (see Knox and Franklin 2015; Leahy and Franklin 2015). Although this is based on somewhat weak evidence and a small sample, it would appear that others with aphasia would also use this app, and further studies can investigate this further.

MJ, CM and BA showed the highest usage of the app during and post intervention. These participants had an average of 122 words and 821 clicks each whereas the others averaged 63 words and 232 clicks. When this is compared to performance at follow up, the same three participants showed significant gains. Originally the app was to gather data on the number of overall clicks (i.e. the number of times a participant touched items to practice) and also the number of clicks per specific treatment item. This data was to be examined alongside performance on the particular words post therapy and at follow-up however incorrect data stamps were recorded and therefore no data for specific items could be used. Collecting usage data on specific words clicked in future studies will also allow better examination of the relationship between practice and performance.

While self-administration of treatment at home required that participants have access to an internet connected device, participants were provided with inexpensive smartphones. An unexpected finding was that many participants either had recently acquired their own tablet or smartphone or had access to one. As the app is web-based, it can be accessed from a range of devices and therefore the client is not obliged to use an expensive device. It is anticipated that this may apply to others in this population. It is also hoped that the app can be made freely available however it is not yet known whether a small fee will be needed to cover the necessary enhancements. The findings are very encouraging in terms of the potential for a low-cost means of supplementing traditional face-to-face therapy sessions, and for extending rehabilitation efforts beyond the point when the available therapy block ends.

Finally, subjective observation was that the participants in this study took great pride in being able to work somewhat independently on their naming using a tablet or smartphone; furthermore, using errorless learning through repetition seemed to instil confidence in participants who otherwise found confrontation naming frustrating and time consuming.

This bodes well for the acceptability of the app for future users. When looking at the bigger picture of aphasia rehabilitation, it may be important to investigate the impact that mode of therapy delivery has upon restoration of self-esteem, as well as quality of life outcomes. Related studies by Knox and Franklin (2015) and Leahy and Franklin (2015) touched on this by looking at the experience of these app users using a qualitative thematic analysis of participant interviews.

5.2 Is facilitation naming therapy effective in improving naming performance in PWA when self-administered via a customisable, web-based app (SANTA)?

These results are also promising from several perspectives. First is the finding that a facilitation naming therapy, utilizing repetition in the presence of the spoken word and picture, resulted in gains for five out of six participants and significant improvement for three participants who all presented with very different aphasia profiles. This finding is in keeping with the idea that facilitation techniques are simple but effective in treating anomia (Howard *et al* 2006). It is important to note that this study was carried out on a small number of single participants over a short period of time. If replicated with a larger sample over a longer period, the ability to apply a simple but effective therapy approach to most clients with anomia will be a welcome finding for clinicians.

The fact that these results in naming improvement were achieved while using a self-administered customisable app are also promising. This finding suggests that self-administered, customisable, web-based, facilitation naming therapy can be beneficial to people with anomia secondary to aphasia. This study was not designed to determine the relative benefit of this mode of therapy delivery as compared to others; however, this is a question that should be investigated in future studies.

One participant's gains were not statistically significant due to a small set size. This was from a small number of items being added and technical issues causing pictures to be missing from the app on follow-up. Set size was further reduced when comparing low frequency words at follow-up. However he did show twice the percentage correct on treated vs untreated items, therefore with better software to eliminate technical issues and longer intervention periods, larger set sizes could be assessed in future studies. Also, adding a

minimum number of words to the app at the beginning will allow for more reliable testing pre and post intervention.

One of the participants did not make any gains in treated words relative to untreated words. This participant was only five months post CVA at the time of the study and lost his device several times, cutting short the intervention period. The same participant also reported using the app more for reminiscence purposes or conversation starters (see Leahy and Franklin 2015; Knox and Franklin 2015). Therefore his results must be interpreted with caution. Future studies with larger samples should be more rigorous with inclusion criteria to avoid potential issues with data reliability.

Generalisation to untreated items was not expected. However for some participants (MJ, CM, CV and PM) the significant change was shown over time using Cochran overall Q tests. However, when removing the post therapy measurement (which was taken after less than two months), there is no significant difference between pre therapy and at follow-up (using the McNemar test) for all but one participant (CV). This indicates that the spike in performance may have been due to practice effects. Future studies should have longer therapy periods which will ensure that measures are taken at longer intervals to reduce the practice effect.

CV showed no significant difference from pre therapy to post therapy on control items but had a spike at follow-up. As pre and post measures were administered by an RA without special training or experience with communication disorders, it may be that on follow-up, the speech and language therapy students were more attuned to his dysarthric speech and therefore attributed more correct productions. It could also be due to the practice effect previously mentioned as the time between testing was short. Future studies should ensure all those carrying out training are equally trained in the area, either by having all speech and language therapy students/clinicians or by having the same people carry out the testing at each measurement time.

The ability to add an infinite amount of functional words to the app coupled with recent research into treating large set sizes could be a way to address the lack of generalisation to untreated words in anomia therapy. Generalisation of treated words to conversation could

be addressed in future versions by adding the option to practice the words at phrase and sentence level based on conversation topics.

6. Conclusion

This study reports the individual findings of six participants who self-administered facilitation naming therapy via a web-based app at home with the support of a friend or family member following brief training. Caution must be exercised in drawing conclusions from these findings given that these are data from single participants. The findings of this study suggest that self-administered facilitation naming therapy via a web-based app is feasible and effective.

Overall findings are consistent with those reported by Ramsberger and Marie (2007). However, one important difference between the treatment approach used in this investigation and that of Ramsberger and Marie has to do with the delivery of the therapy. Their treatment procedure utilized clinician-designed practice exercises, requiring adaptation of the app's existing vocabulary to clients' needs by the clinician. This raises the question as to whether truly independent functional therapy can be achieved using apps with limited vocabulary and requiring clinician involvement. Many PWA find it particularly difficult to retrieve proper names including friends, family and place names (Robson *et al* 2004) which would be highly useful to practice. An app which can be fully customised by the client has endless possibilities for therapy outside of the clinic in more appropriate functional contexts.

Results suggest that a fully customisable self-administered, web-based, facilitation naming therapy app using errorless learning may be beneficial to a wide range of people with anomia regardless of their age or aphasia profile. This demonstrates the potential of an app such as SANTA as an alternative treatment model. Further study is encouraged to hopefully result in a low-cost supplement or alternative to traditional clinician-led, clinic-based anomia therapy, resulting in better outcomes for people with chronic aphasia.

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Appendix
Aphasia friendly consent form:



Department of Clinical Therapies, University of Limerick

Consent Form

I read the information leaflet 	YES 	NO 
I had an opportunity to ask questions 	YES 	NO 
I was satisfied with the answers to my questions 	YES 	NO 
I understand what is involved 	YES 	NO 
I understand that information is kept safe and private 	YES 	NO 
I know I can stop at any time 	YES 	NO 
I agree to being video-recorded 	YES 	NO 
I consent to the researchers seeing my medical records 	YES 	NO 
I consent to my app data being tracked 	YES 	NO 

I agree to participate in this study.

Name: _____ Name Researcher: _____

Signature: _____ Signature Researcher: _____

Date: _____