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The feasibility, usability and acceptability of a tablet-based aphasia therapy in the acute phase following stroke

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A R T I C L E I N F O

Keywords:
Aphasia
Stroke
Tablet-based therapy
App
Rehabilitation

A B S T R A C T

Question: Independent practice via an application with a language exercise program for aphasia, as an add-on to conventional care can be a good solution to intensify aphasia therapy. The aim of this prospective trial was to investigate the feasibility, usability and acceptability of the newly-developed aphasia exercise program in the 'Speech Therapy App (STAPP)' in the acute phase post-stroke.
Methods: All eligible people with aphasia following stroke (<2 weeks post-stroke) admitted to the Stroke Unit of Ghent University Hospital were recruited in this prospective clinical trial between September 2018 and December 2019. After linguistic assessments and two short training sessions, participants were asked to practice independently with 'STAPP' for at least 30 min/day during hospitalization. Exercises were individually tailored and adjusted if necessary. Outcome was measured by recruitment, adherence and retention rates, usability questionnaires and a visual analogue scale for satisfaction.
Results: Twenty-five (mean age 65 years (SD = 17), 14 females) of 31 eligible people with aphasia were enrolled in this trial (recruitment rate = 81 %). All participants but one (23/24) practiced with the language app until the end of hospitalization (retention rate = 96 %). Ten participants practiced at least 30 min/day (adherence rate = 42 %). Participants reported they learned to work quickly with the app (92 %; agreed/totally agreed), the app was easy to use (88 %), they could work independently (79 %), practiced their language (67 %) and wanted to continue working with the app at home (79 %). Acceptability was high (median satisfaction rate 91 %; IQR = 75–100).
Conclusion: The aphasia exercise program in 'STAPP' is feasible to use as an additional rehabilitation tool along with standard of care in the acute phase post-stroke. Further research is needed to assess the efficacy.
Clinical Trial Registration-URL: https://clinicaltrials.gov/ct2/show/NCT03679637.

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1. Introduction

Aphasia is a common symptom following stroke, present in 20–40 % of people in the acute phase (De Cock et al., 2020; Engelter et al., 2006; Flowers et al., 2016). Considerable spontaneous recovery is initiated in the first few months, due to neuronal plasticity and reorganization processes (Demeurisse et al., 1980; Sarno & Levita, 1971). However, in a significant proportion of individuals following stroke, aphasia persists in the chronic stage of recovery (Dijkerman, Wood, & Hewer, 1996). It is well known that aphasia not only affects verbal communication, but also has a major impact on a person's quality of life (Hilari, Needle, & Harrison, 2012; Numminen et al., 2016). Several lesion-, person- and treatment-related factors have been identified to impact aphasia prognosis in individuals following stroke (Watila & Balarabe, 2015). Better language recovery is expected in people with smaller lesions who are not located in critical language regions and in those with a milder aphasia at onset (Watila & Balarabe, 2015). Therapy type, duration, intensity and time of onset are considered important determinants of aphasia treatment (Watila & Balarabe, 2015). There is evidence that intensive aphasia therapy might lead to better language outcomes, but the desired intensities for rehabilitation (minimum 8 h per week) are difficult to achieve in clinical practice (Bhogal, Teasell, & Speechley, 2003; Brady, Kelly, Godwin, Enderby, & Campbell, 2016; Breitenstein et al., 2017). In the acute phase, people have a high load of other investigations and treatments, and factors such as initial stroke severity and fatigue might also preclude adequate aphasia therapy. In the subsequent rehabilitation phase, mobility and transportation difficulties and limitations in reimbursement of therapy sessions might reduce therapy intensities (Lavoie, Macoir, & Bier, 2017; Macoir, Lavoie, Routhier, & Bier, 2019). A possible solution to intensify rehabilitation is the use of technology-delivered aphasia therapy.

The last few years, computers and mobile tablets have become increasingly integrated into aphasia therapy (Lavoie et al., 2017; van de Sandt-Koenderman, 2011). The use of technology in treatment has several advantages such as the possibility of self-administered practice, reduced transportation time for the person with aphasia and/or therapist and the possibility to increase treatment intensity in a cost-effective manner (Latimer, Dixon, & Palmer, 2013; Macoir et al., 2019; Mashima & Doarn, 2008). However, self-administered aphasia therapy is not suitable for all people, e.g. motor and cognitive comorbidities should be taken into account (Macoir et al., 2019; Mashima & Doarn, 2008). There is a growing body of literature demonstrating the efficacy of technology-delivered aphasia therapies (Lavoie et al., 2017; Palmer et al., 2019; Zheng, Lynch, & Taylor, 2016). Several trials have also investigated the feasibility of specific language apps and/or software (Cherney, Halper, & Kaye, 2011; Choi, Park, & Paik, 2016; Gerber et al., 2019; Hill & Breslin, 2016; Mallet et al., 2016; Palmer et al., 2012; Pugliese et al., 2019). Although people with aphasia encountered some barriers, they generally had positive experiences (Palmer, Enderby, & Paterson, 2013; Pugliese, Ramsay, Johnson, & Dowlatshahi, 2018). Aphasia therapy is often started as soon as possible post-stroke. Early onset rehabilitation might reinforce spontaneous neuroplasticity leading to better functional recovery (Bernhardt, Godecke, Johnson, & Langhorne, 2017; Coleman et al., 2017). Therefore, tablet-based aphasia therapy as add-on to standard care in the acute phase following stroke could be a good solution to increase therapy intensities and reinforce spontaneous recovery. However, only limited research has focused on the implementation of technology-delivered aphasia therapy in the acute phase post-stroke. To our knowledge, only two other trials have investigated the feasibility of an independent tablet-based aphasia therapy in the acute phase post-stroke (<2 weeks), and both trials used the 'RecoverNow' rehabilitation program (Mallet et al., 2016; Pugliese et al., 2019). In the first trial, people with mild to moderate communication disorders (NIHSS score >1 on the best language and/or dysarthria items) were included in a prospective, observational study evaluating the use of commercially available apps via the 'RecoverNow' platform in the acute phase following stroke (Mallet et al., 2016). After initial face-to-face assessment and a 15 min training by an experienced SLP, therapy was individually tailored and participants were asked to practice for at least 1 h per day. Daily monitor visits were provided by the research coordinator. Outcome measures included recruitment, adherence and retention rates, acceptability measures and the evaluation of possible barriers. Thirty out of 44 eligible participants (68 %) were recruited into this trial. Nearly all continued to practice with the platform until the end of hospitalization (97 % retention rate), for a median of 129 min per day. The authors conclude that individualized therapy via the 'RecoverNow' platform is feasible in the acute phase post-stroke. In a follow-up trial, the platform was transformed into a more holistic rehabilitation program, including speech-language exercises, as well as cognitive and motor training (Pugliese et al., 2019). Participants were able to continue practice at home for three months after hospital discharge. Almost half of the eligible participants enrolled in the trial (30/62; 48 %). Retention rate was 77 % and participants practiced with the speech-language exercises for a median of 12 min per day. The researchers propose to address person, system and device-related barriers to successfully implement technology-delivered aphasia therapy in the future.

Recently, the newly-developed aphasia exercise program in the 'Speech Therapy App (STAPP)' is available for Dutch-speaking people with aphasia. The aim of this trial was to examine the feasibility, usability and acceptability of tablet-based aphasia therapy via 'STAPP' as add-on to standard of care in the acute phase post-stroke.

2. Methods

2.1. Participants

All people consecutively admitted to the Stroke Unit of Ghent University Hospital between September 2018 and December 2019 were prospectively screened for eligibility. Inclusion criteria were 1) the presence of aphasia following acute stroke as determined by the ScreeLing and the BNT (study inclusion <2 weeks post-stroke), 2) aged 18 year or older and 3) minimum proficient language level of Dutch. People with severe psychiatric, cognitive and/or visual disorders that hindered technology-delivered aphasia therapy were excluded by evaluating their ability to perform basic 'mobile tablet skills' (e.g. clicking and swiping). Demographic and medical information such as age, sex, handedness, time of stroke onset, stroke type, the National Institutes of Health Stroke Scales (NIHSS) and

Modified Rankin Scale (mRS) at hospital admission and length of hospital stay were documented. This trial was approved by the Ethics Committee of Ghent University Hospital (EC/2018/1006). Written consent was obtained from all participants, or a legal representative in the case of severe comprehension difficulties.

2.2. Procedures

This trial was a prospective, observational study. Standardized linguistic assessments to determine stroke severity and comprehension abilities (e.g. the ScreeLing, BNT, PALPA 1, 2, 5 and the Token Test (Hachioui, van de Sandt-Koenderman, Dippel, Koudstaal, & Visch-Brink, 2012; Huber, Poeck, Weniger, & Willmes, 1983; Kay, Coltheart, & Lesser, 1992; Roomer, Hoogerwerf, & Linn, 2011)) were performed in all participants before the start of intervention. At the same time, participants were also questioned on their previous computer and mobile tablet experience. After two short training sessions (15–30 min) participants were asked to practice independently with the language exercise program in 'STAPP' as an add-on to standard care until the end of hospitalization. All participants received a user-friendly instruction sheet with step-by-step illustrations on how to use the app. Standard care SLP services generally involved extensive (differential) diagnostic assessment and initiation of treatment for speech, language and swallowing disorders. Aphasia rehabilitation included individually tailored cognitive-linguistic treatment, in line with the tablet-based therapy. Participants could use hospital mobile tablets (iPad Air 2), which were cleaned with disinfectant wipes before and after transfer to another participant, as was advised by the hospital department of Infection Prevention. No personal information was registered in the app software, assuring participant confidentiality. At the last day of hospitalization, questionnaires concerning the usability and acceptability of the app were administered.

2.3. Tablet-based aphasia therapy

'STAPP' is a newly-developed online therapeutic application for Dutch-speaking people following brain damage and consists of two separate modules, the Therapeutic Instrument for Speech Apraxia (TIAS) and the Module Specific Treatment (MST) for language rehabilitation (Feiken, 2016; Feiken, Hüttmann, & Links, 2020). The language exercise program MST is a type of cognitive-linguistic therapy, aimed at restoring specific impaired language processes according to the neurocognitive model of Ellis & Young (Ellis & Young, 1996; Feiken et al., 2020). The neurocognitive model is demonstrated in the interface of the app and by simply clicking on a specific language process (e.g. phonological input lexicon, semantic system), the clinician can choose from a list of exercises targeting that process (e.g. auditory comprehension, word categorization). Number of items per exercise and total number of exercises can be individually chosen and adjusted. Difficulty of exercises can be set to easy or difficult, with word length, frequency, imageability and the number and type of distractors automatically adjusted. The person with aphasia can choose to use several cues during exercises, such as a written or spoken word, a description or image.

Based on the diagnostic assessments and complementary to standard of care, the therapy program was individually tailored by the SLP (results of diagnostic assessment are reported in Table A1 of the Supplemental Materials). Type and number of exercises, number of items per exercise and difficulty level were carefully selected. Participants were encouraged to practice independently for a minimum of 30 min per day, with no upper limit. Written responses and exercises that require a selection were automatically scored right or wrong by the app. Oral production tasks were evaluated by participants via self-assessment by comparing their answer to the one provided by the app. Exercises using self-assessment were avoided in participants who were unable to do so as observed by the SLP during the training sessions. At the end of each exercise, a detailed performance report was visible for the participant (e.g. number of errors and cues used, time spent per item and exercise). The SLP could consult this information and adjust the therapy program from a distance. In general, participants were encouraged to repeat each exercise several times. The SLP checked the performance reports daily and adjusted exercise difficulty or introduced new exercises when improvements in accuracy and timing were observed. Participants had to practice in their own (mostly shared) room during standard care and tablet-based aphasia therapy, but precautions were taken (e.g. the use of a separation curtain) to minimize disturbance to roommates and maximize privacy. Daily face-to-face visits were performed to further motivate participants to practice and inquire about any encountered problems or difficulties with specific exercises. Participants who were not able to practice independently after two training sessions received additional training for their difficulties during the daily visits by the SLP for as long as they needed. Independence of the participant was promoted by offering as little help as possible.

2.4. Outcome measures and data analysis

Feasibility of tablet-based aphasia therapy in the acute phase following stroke was determined by measuring recruitment, adherence and retention rates. Recruitment rate was defined as the number of participants included in this trial divided by the number of eligible people with aphasia. All individuals admitted to the Stroke Unit at Ghent University Hospital were screened for aphasia by one of two trained SLPs. The same SLPs provided the eligible participants and their caregivers with the study information and obtained written approval. People who were not yet eligible, e.g. due to reduced alertness or other severe comorbidities were followed up for later recruitment when possible (within 2 weeks post-stroke). Adherence rate was measured as the number of participants who were able to practice the recommended 30 min per day (total time practiced during hospitalization/number of possible days of practice). When a participant practiced for less than a mean of 30 min per day, we coded the participant as not adherent. Total usage time per exercise was automatically logged by the app. Retention rate was defined as the number of participants who continued practicing until the end of hospitalization. Remarks concerning recruitment, adherence and retention rates were carefully documented. A self-prepared observational checklist and questionnaire (specifically created by the research group for the purpose of this study) were administered to assess the usability of the app. The SLP observed each participant during practice with the language exercise program in 'STAPP' and scored the level of independence on several tasks using a 3-point scale (1 = completely dependent, 2 = needed some help, 3 = completely independent). For the questionnaire, participants had to score five statements concerning software usability on a 5-point Likert Scale (1 = totally not agree, 5 = totally agree). The questionnaire was based on The System Usability Scale (SUS), but only positive statements were included to avoid confusion for participants with comprehension difficulties (Brooke, 1996). Positive and negative feelings concerning the app were elicited via open-ended questions. The SLP transcribed all oral answers and carefully documented written responses and/or drawings. Acceptability, expressed by the overall satisfaction rate with the app, was measured on a vertical VAS-scale ranging from 0 to 100 %. The SLP aided all participants during outcome measurements by providing visual feedback such as written words/sentences to improve overall comprehension.

Descriptive statistics were reported as percentages and number of participants, % (n) and means (SD) or median (IQR). To determine the relationship between the factors age, length of hospital stay, stroke severity (total NIHSS score at admission), aphasia severity (Token Test score), previous computer or mobile tablet experience and adherence, retention and the ability to practice independently, the Fisher's Exact test for categorical and the Mann Whitney *U* test for continuous variables were performed ($p < 0.05$ being statistically significant).

3. Results

3.1. Study population

Between September 2018 and December 2019, 25 people with aphasia (mean age 65 years (SD 17), 14 females) were enrolled in this trial at the stroke unit of Ghent University Hospital. The median time of enrolment post-stroke was 5 days (IQR = 3–6) and median length of hospital stay was 9 days (IQR = 6–14). Participant characteristics are reported in Table 1. Most participants had previous experience with a computer (16/25) or mobile tablet (17/25); however, 7 participants had no previous experience with either device.

3.2. Feasibility

3.2.1. Recruitment, retention and adherence rates

Twenty-five of 31 eligible people with aphasia were enrolled in this trial, resulting in a recruitment rate of 81 %. (flowchart, Fig. 1).

Table 1
Participant characteristics.

Characteristics	Total n = 25
Age in years, mean (SD)	65 (17)
Female sex, % (n)	56 (14)
Right-handedness, % (n)	96 (24)
Stroke type, % (n)	
Ischemic stroke	84 (21)
Intracerebral hemorrhage	16 (4)
NIHSS hospital admission, median (IQR)	7 (3–15)
Motor impairment (according to the NIHSS), % (n)	60 (15)
mRS hospital admission, median (IQR)	3 (2–4)
Time post-stroke until study enrolment in days, median (IQR)	5 (3–6)
Aphasia severity (Token Test Score), % (n)*	
Minimal	24 (6)
Mild	24 (6)
Moderate	24 (6)
Severe	20 (5)
Previous computer experience (self-reported)	
Daily	52 (13)
Weekly	12 (3)
Monthly	0 (0)
Never	36 (9)
Previous mobile tablet experience (self-reported)	
Daily	40 (10)
Weekly	16 (4)
Monthly	12 (3)
Never	32 (8)
Length of hospital stay in days, median (IQR)	9 (6–14)

SD = standard deviation, n = number of participants, IQR = interquartile range, NIHSS = the National Institutes of Health Stroke Scale (score <5 = mild; 5–14 mild to moderately, 15–24 severe, >25 very severe impairment), mRS = Modified Rankin Scale (score 0–2 = no, no significant or slight disability, 3 = moderate, 4 = moderately severe, 5 = severe disability, 6 = dead).

* Token Test score is missing in 2 participants (1 participant was too emotional/tired, 1 had too severe hearing loss for adequate interpretation).

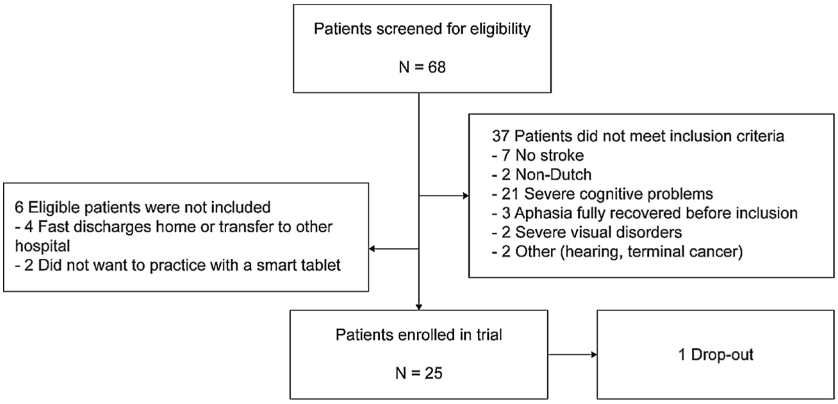

Fig. 1. Flowchart of people with aphasia included in the study.

One participant dropped out due to unforeseen early discharge from the hospital. Retention rate was 96 % (23/24). Only one participant did not practice until the end of hospitalization as she felt the exercises were no longer useful for her (mild aphasia, long hospitalization). Adherence rate was 42 % (10/24). Participants practiced a median of 23 min per day (IQR = 9–34). Three participants practiced for a mean of more than 1 h per day and 10 for less than 15 min per day (inter and intra-individual usage times per day are displayed in Figs. B1 and B2 of Supplemental Materials). Self-reported reasons why participants did not adhere to the recommended therapy intensity were the inability to practice independently, feeling tired and/or low-spirited, forgetting about it, feeling embarrassed to practice in front of roommates, and occupation with other treatments, investigations and/or visitors.

3.2.2. Protocol deviations

Due to time constraints and/or high initial stroke severity, extensive diagnostic assessment was not possible in 3 participants. Exercises were then selected based on the results of a short screening test. Ten participants only needed one training session before practicing independently with the app, while six needed more sessions and 3 participants were never able to practice independently. In two occasions, participants were allowed to leave the hospital in the weekends, continuing practice at home.

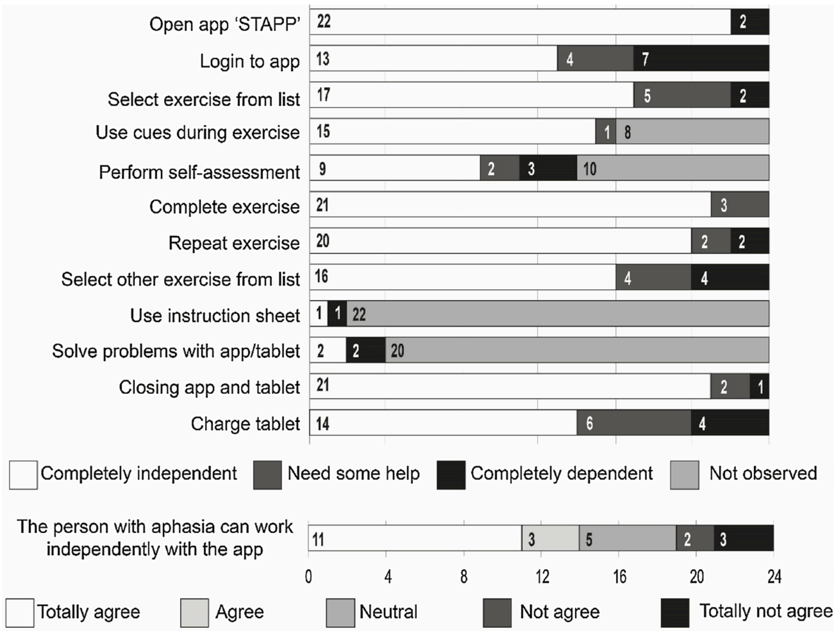

Fig. 2. Observational checklist: level of independence for several app/tablet-based tasks. The last statement concerns the overall level of independence as scored by the SLP on a 5-point Likert Scale.

3.3. Usability

3.3.1. Observational checklist

Level of independence in app/tablet-related tasks is reported in Fig. 2. Overall, 58 % of participants (14/24) were able to work independently with the app. Most problems occurred when opening the app (e.g. clicking on a different app, not remembering which one), log in with a nickname and password using the on-screen keyboard (e.g. fine motor problems, typing errors, forgetting login information), selecting exercises (e.g. not clicking on the right button), and recharging the battery.

3.3.2. Usability questionnaire

Results of the statements in the self-prepared Usability Questionnaire are shown in Fig. 3. The most frequent reported positive feedback was that the app is educational and participants felt like they learned a lot (n = 6). Other positive comments were that there was a lot of variability in exercises and vocabulary (n = 3) and they could practice independently, at their own pace (n = 3). The cueing system and visual feedback was good (n = 3), the app was found to be user friendly (n = 2) and working with it increased motivation and self-confidence (n = 2). The most common reported negative aspect was that exercises were sometimes perceived as too easy or difficult (n = 5). Other comments were that the language used in the app is not adjusted to Flemish users (n = 3), the computer voice is not always easy to understand (n = 2) and they felt they had to repeat the same exercise too much (n = 2). Some suggestions for improvement were made such as adjusting the language use to Flemish users. Five participants with severe aphasia were not able to answer the open-ended questions, and 8 participants specifically mentioned they had no negative comments to report.

3.4. Acceptability

Participants had a median satisfaction rate of 91 % (IQR = 75–100).

3.5. Factors related with adherence, retention and independence

Moderate aphasia severity and the lack of previous computer and mobile tablet experience was significantly associated with the inability to work independently with the app (p = 0.011 and 0.009 respectively). No other factors were significantly related with adherence and retention rates.

4. Discussion

This prospective trial evaluated the feasibility, usability and acceptability of a newly-developed language exercise program via the application ‘STAPP’ in people with aphasia following stroke in the acute phase. As far as we are aware, our and two other trials are the only studies who have investigated the feasibility of an independent tablet-based aphasia therapy in the acute phase post-stroke (Mallet et al., 2016; Pugliese et al., 2019). Recruitment rate in our trial was higher than in the previous trials, mainly explained by the consecutive screening of all incoming people with stroke for eligibility and the low percentage of persons discharged home or transferred to another hospital setting before enrolment (Mallet et al., 2016; Pugliese et al., 2019). In our trial, tablet-based aphasia therapy was only delivered during hospitalization in the acute phase post-stroke, as also was the case in the first trial using the ‘RecoverNow’ platform (Mallet et al., 2016). Retention rate in our and their study was similar (97 % and 96 % respectively). The other trial, allowing continued practice with the ‘RecoverNow’ application at home, reported a lower retention rate of 77 % (Pugliese et al., 2019). Possible reasons for the higher retention rate in our study are daily face-to-face visits from the SLP to monitor study progress, social control, the quick resolution of encountered problems and adjustments of exercises during a relatively short period of hospitalization. A recent review corroborates these findings, describing guidance and training of participants together with regular SLP contact as important factors for successful technology-delivered aphasia therapy (Macoir et al., 2019). Participants in our trial practiced a median of 23 min per day with the language exercise program in ‘STAPP’. The previous trials performed in the acute phase

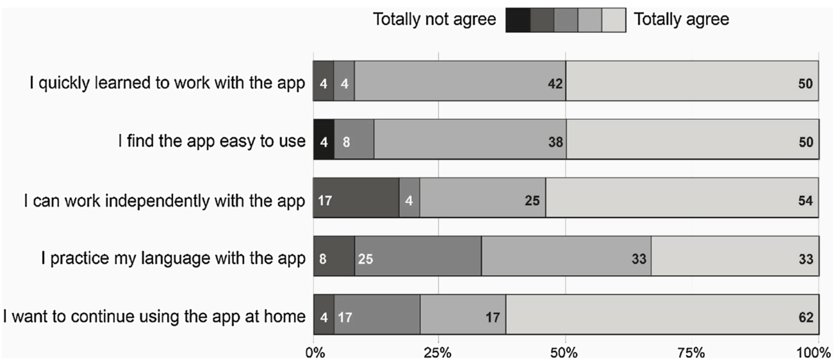

Fig. 3. Results of the 5 statements included in the usability questionnaire as reported by participants on a 5-point Likert Scale.

post-stroke, reported a median of 129 min per day during hospitalization only, and a median of 12 min per day in the trial with continued practice at home (Mallet et al., 2016; Pugliese et al., 2019). However, both of these studies reported overall mobile tablet iOS usage data including time spent with non-restricted Apple apps (e.g. clock, calendar). In our trial, 'STAPP' automatically registered the time spent per exercise, leading to a much more precise estimate of therapy adherence. Although less than half of participants adhered to the predefined therapy intensity, a median practice time of more than 20 min per day during hospitalization can be considered as a good outcome in the current trial, as we also included more severe strokes with multiple co-morbidities. This is in line with two previous RCTs, recommending a 20–30 min of practice per day with the 'StepByStep' software as this was feasible and led to clinically significant improvements in finding of personally relevant words (Palmer et al., 2012, 2019). In the chronic phase post-stroke, trials reported mean usage times of (mainly) independent practice, ranging between 28 h over a 6-month period to 30 h in 4 weeks (Choi et al., 2016; Des Roches, Balachandran, Ascenso, Tripodis, & Kiran, 2014; Kurland, Wilkins, & Stokes, 2014; Lavoie, Bier, & Macoir, 2019; Palmer et al., 2019; Roper, Marshall, & Wilson, 2016; Stark & Warburton, 2016). Overall, it seems that lower intensities were reported in studies performed over a longer period of time and with less (face-to-face) SLP monitoring. This underscores the importance of using tablet-based practice as add-on to conventional aphasia therapy, especially with long-term use. More than half of our participants (58 %) were able to practice independently with 'STAPP' as observed by the SLP, with little need for training in advance. Only one other trial also observed participants during tablet-based aphasia therapy (Hill & Breslin, 2016). The level of independence during observation is difficult to compare between our and their trial as they included a small sample size (n = 5) of people with aphasia in the chronic phase post-stroke, and used a different telerehabilitation platform (eSalt). Although participants in our trial were screened for eligibility by evaluating basic mobile tablet skills, three participants were never able to practice independently with the language exercise program in 'STAPP'. These participants received further training and assistance from the SLP, but they were encouraged to perform the tasks as independently as possible. Reported barriers to independent technology-delivered aphasia therapy in previous research are in line with the current trial. The presence of motor, visual and/or cognitive deficits made it difficult for some to manipulate a mobile tablet (e.g. touchscreen, scroll bar and on-screen keyboard), understand complex instructions and resolve technical issues (Hill & Breslin, 2016; Mallet et al., 2016; Pugliese et al., 2019). Previously proposed solutions for these person-related barriers included training for caregivers and the use of computer access aids (Pugliese et al., 2019). Several device-related barriers were reported in our and previous research such as exercises sometimes being too easy or too difficult (Hill & Breslin, 2016; Pugliese et al., 2019). A possible reason is that difficulty level was based on initial language assessment, however symptoms might resolve quickly in the acute phase post-stroke, necessitating continuous therapy adjustments (Pugliese et al., 2019). In our trial, exercise difficulty was adjusted daily by the SLP based on previous performances; however, an automatic evaluation and adjustment system incorporated in the app would ensure more precise tailoring of exercises. On the other hand, the self-reported barrier of exercises being too easy or difficult might be a result of a deficit in self-awareness, making it challenging for some people to correctly assess their own language abilities. The implementation of automatic speech recognition (ASR) providing feedback on exercise accuracy can circumvent this problem. One participant in our study identified practicing in public as a barrier, which was resolved in a previous trial by using a headset (Mallet et al., 2016). Specifically for the current trial, participants felt that some regional language differences between Flanders and the Netherlands (e.g. pronunciation and vocabulary) should be adjusted for future use. Ideally, the users can switch to the desired language setting in the app. Despite the above reported barriers in our and previous research, it is encouraging that most participants were able to engage in independent tablet-based aphasia therapy. Only the lack of previous computer or mobile tablet experience and the presence of moderate aphasia severity were negatively related with the level of independence. Adequate training of the participant and caregiver is therefore a key factor for successful technology-delivered therapy. In line with previous research, participants felt that they quickly learned how to work with the software and reported an increase in self-confidence (Cherney et al., 2011; Gerber et al., 2019; Hill & Breslin, 2016; Ramsberger & Marie, 2007; Routhier, Bier, & Macoir, 2016). Positive characteristics and attitudes reported about the tablet-based aphasia therapy were further confirmed by the high scores on the usability questionnaire, and the large number of participants wanting to continue practice at home. Overall acceptability with the technology-delivered aphasia therapy in the current trial was very high with a median satisfaction rate of 91 %. Although assessed via other outcome measurements, a high level of acceptability was also reported in previous research (Cherney et al., 2011; Choi et al., 2016; Hill & Breslin, 2016; Mallet et al., 2016; Routhier et al., 2016). Our trial had some limitations. First, participants had a relatively short length of hospital stay and could therefore not practice for a long time period, which might have reduced the level of independence as observed on the observational checklist for some. On the other hand, the short time period and daily SLP guidance might have motivated participants to practice more, leading to higher adherence rates and satisfaction. However, no significant relationships were found between length of hospital stay and level of independence and adherence. Second, outcome interviews were performed by the SLP monitoring the tablet-based aphasia therapy which could have made participants more reluctant to give negative comments. However, it was made clear to the participants that their opinions (both positive or negative) were equally valuable. Third, we did not engage the participants' social environment to provide feedback on outcome measures, which might have been helpful for some participants who could not answer the (mostly open-ended) questions. Lastly, we did not examine performance outcomes following the use of the language exercise program in 'STAPP', however, we are currently performing a randomized controlled trial to assess the efficacy of independent tablet-based aphasia therapy with 'STAPP' as add-on to conventional care in the chronic phase post-stroke.

5. Conclusion

This prospective trial confirmed the hypothesis that the language exercise program in 'STAPP' is feasible to use as an additional rehabilitation tool along with standard of care in the acute phase post-stroke. A high number of eligible people with aphasia were able to participate in this trial, and continued to do so until the end of their hospitalization. Although there was a low adherence for the recommended therapy intensity, participants were able to practice with a median of more than 20 min per day. Not all participants were able to practice completely independent with the app and some barriers were encountered, however, overall usability and acceptability with the tablet-based aphasia therapy was very high. Regular face-to-face SLP contact seems to be an important factor for therapy adherence, retention and usability of the app. Lastly, ongoing research is investigating the efficacy of the language app 'STAPP' as add-on to conventional care in the chronic phase post-stroke.

Author statement

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Declaration of Competing Interest

Judith Feiken was involved in the development of the application 'STAPP', however she is not receiving any financial benefit through the app. The 'STAPP' is marketed on a non-profit basis by Center for Rehabilitation, University Medical Center Groningen. The remaining authors have no conflict of interest to declare.

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