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Disability and Rehabilitation

ISSN: 0963-8288 (Print) 1464-5165 (Online) Journal homepage: www.tandfonline.com/journals/idre20

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To cite this article: Niamh Devane, Jane Marshall, Stephanie Wilson & Katerina Hilari (05 Mar 2025): Developing a new aphasia therapy for a virtual world: the Virtual Elaborated Semantic Features Analysis (VESFA) intervention, Disability and Rehabilitation, DOI: 10.1080/09638288.2025.2470401

To link to this article: https://doi.org/10.1080/09638288.2025.2470401

DISABILITY AND REHABILITATION
https://doi.org/10.1080/09638288.2025.2470401

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RESEARCH ARTICLE

Developing a new aphasia therapy for a virtual world: the Virtual Elaborated Semantic Features Analysis (VESFA) intervention

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ABSTRACT

Purpose: Stroke research Priority Setting Partnerships identified a need for interventions that address wellbeing and communication. This paper outlines the development of a communication and wellbeing intervention for delivery in the virtual world, EVA Park, for people with aphasia called Virtual Elaborated Semantic Feature Analysis.

Materials and Methods: The Medical Research Council framework for developing complex interventions was followed to combine evidence (literature review), underpinning theory (semantic processing theories, framework for situated language use and learning theories) and involvement with stakeholders (four people with aphasia and three speech and language therapists) in an intervention that addresses word finding, situated language and wellbeing.

Results: Evidence for the semantic word interventions and situated conversation interventions was synthesised. Theory underpinning the proposed intervention included Hebbian learning, the hub and spokes model of semantic processing, semantic spreading activation theory, the framework for situated language use and learning theories. Stakeholders with aphasia identified intervention content, an acceptable intervention regimen and gave feedback on a taster session. Speech therapists advised how the intervention could be implemented in clinical practice.

Conclusion: Virtual Elaborated Semantic Feature Analysis is a user-informed, theory-based complex aphasia intervention that is expected to improve word finding, word use in situated conversation and wellbeing.

IMPLICATIONS FOR REHABILITATION

- When consulted on acceptable therapy regimens for an aphasia therapy in a virtual world, a lived experience advisory group preferred a distributed regimen (4 days a week over 8 weeks) over a more intense regimen (5 days a week over 6 weeks).
- Individual word retrieval activities and group conversation activities were equally prioritised by the lived experience advisory group.
- It is more challenging to retrieve a word in a conversation context, therefore word retrieval practiced in conversations was valued by the lived experienced advisory group.
- A simulated, supported, virtual space for communication practice, such as groups in the EVA Park virtual world, provides a social context for learning and experiencing success with limited loss of face.

ARTICLE HISTORY
Received 26 June 2024
Revised 14 February 2025
Accepted 16 February 2025

KEYWORDS
Intervention development; aphasia; complex intervention; virtual world; semantic therapy; situated language; PPI

Introduction

Intervention development combines information from evidence, theory and relevant groups of people, such as service users, to create a programme where there is a clear argument for expected outcomes. It represents Phase I in a four-stage process that is the Medical Research Council (MRC) framework for developing and evaluating complex interventions [1]. It precedes feasibility testing (Phase II), intervention evaluation (Phase III) and implementation (Phase IV). This paper outlines the development of a complex intervention, called Virtual Elaborated Semantic Features Analysis (VESFA) that aimed to improve the language and functional communication of people with aphasia following stroke.

Stroke is a leading cause of disability worldwide [2]. Approximately a quarter of stroke survivors will experience the chronic disability of aphasia [3]. Aphasia is a language disorder impacting auditory comprehension, reading, oral expressive language and writing to varying degrees [4]. Aphasia is associated with far reaching consequences for conversations, social networks, healthcare access, mood, and quality of life [5–7]. Although there is no cure, speech and language therapy rehabilitation for aphasia improves outcomes [8].

The top priorities for stroke rehabilitation research are interventions that address wellbeing and communication (James Lind Alliance Priority Setting Partnerships). In line with this, there are calls for evidence-based interventions that address the use of language in real life contexts [9]. Novel and alternative modes of

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/09638288.2025.2470401.
This article was originally published with errors, which have now been corrected in the online version. Please see Correction (http://dx.doi.org/10.1080/09638288.2025.2523212).

therapy delivery might help this need. For example, multi-user virtual worlds are uniquely placed to provide simulated everyday environments in which to practice language in context [10].

EVA Park is a multi-user virtual world developed with and for people with aphasia [11]. It is a virtual island with multiple locations, including a café, houses, gardens and a hair salon, where users can meet and interact. Users log in from home, are represented as avatars and communicate through speech and/or instant messages in real time. Avatars can walk, run or fly around EVA Park. They are controlled by the user using a limited set of keys on a standard computer keyboard. EVA Park has been used to deliver language and communication therapies and for group social support [11–15]. In this paper we describe the development of a novel EVA Park intervention, VESFA, that will target word retrieval, using the well documented and well evidenced procedures of Semantic Feature Analysis (SFA) [16,17], and promote functional communication through an elaboration in which words practiced in SFA are then produced in phrases [18] and in situated conversations in the virtual world. It combines individual and group therapy.

Previous accounts of intervention development for aphasia interventions are few [19–27]. All have described a multi-stage approach. The number of stages differ across accounts but have typically included identifying the underlying theory and evidence base [28], consulting and/or working in partnership with future end users [20,27] and documenting therapy content in a manual [20]. To exemplify [26], developed a communication partner training for people with primary progressive aphasia and described a 6-stage process: 1) examining literature 2) consultation and co-production 3) initial manual draft 4) consensus work with speech and language therapists 5) focus groups with people with aphasia and 6) refinement of the manual.

This paper articulates the development of the VESFA intervention, specifying what each component of the intervention set out to achieve. Development followed the MRC's framework for developing complex interventions [1,29,30]. The development process reviewed the evidence base and theoretical literature relevant to the proposed therapy. This ensured that VESFA was theoretically motivated and that it built upon treatments showing evidence of benefit. Involvement with relevant stakeholders ensured that the therapy would be relevant and acceptable to those who will receive and deliver the intervention, hopefully supporting future implementation. The purpose of this work was to both address the need for language in context therapies and support the testing of the intervention and ultimately its adoption in clinical practice.

Intervention development framework

Working from the MRC framework, O'Cathain et al. (2019) provide detailed guidance for intervention developers (see Table 1). This guidance was followed in the development of VESFA. This paper describes how evidence, theory and stakeholder views were applied. It is presented in 3 phases: Phase 1 outlines desk-based research that systematically explored the literature and specified the theoretical basis. Phase 2 describes involvement through stakeholder consultation. In phase 3, describes how the programme was produced, refined and operationalised in a therapy manual ready for feasibility testing. See GUIDED checklist (Supplemental Material S4), guidance for reporting intervention development studies in health research [33].

Table 1. Actions to guide intervention developers (O'Cathain et al. 2019) with corresponding phases in the VESFA development.

VESFA phase	Guidance for developers	VESFA intervention development actions
Phase 1 | Desk research	**Plan the development process.** Includes determining the need for the intervention, obtaining funding, and producing a protocol.	The need for the intervention was identified following a trial of ESFA and preliminary protocol was outlined in the proposal for VESFA funding submitted to (City University of London) in 2018.
	Bring together a team. Include individuals with relevant expertise. Establish a decision-making process	The author team met regularly to review progress. The team held expertise in ESFA and clinical trial methodology, EVA Park interventions and Human Computer Interaction Design.
	Review published research evidence. Understand the evidence for each component of the intervention	The evidence for SFA, group intervention and the use of virtual reality (VR) for aphasia therapy was reviewed. Findings for the first two areas are summarised in this paper. A systematic review of VR aphasia interventions has been published by our team [31]
	Draw on existing theories. Identify the theories that underlie the therapy components	The theories that underlie the therapy components are outlined in this paper.
Phase 2 | Involvement	**Involve stakeholders.** Identify the relevant stakeholders, plan involvement, and identify the best ways of working with each group.	Established a Lived Experience Advisory Group (LEAG) of people with aphasia and identified expert speech and language therapists to advise on current context and implementation.
	Understand the context. Consider factors that influence implementation	Focus groups were run with aphasia specialist SLTs from both national health service and independent practice.
	Pay attention to future implementation. Understand the barriers and facilitators of future use of the intervention	The Lived Experience Advisory group and SLT focus groups discussed acceptable regimens and implementation in clinical practice. The barriers to faithful delivery of the intervention are described in a paper on treatment fidelity (in preparation).
	Undertake primary data collection. Use a range of research methods to understand the context and intermediate outcomes	A qualitative study was undertaken to explore what topics were considered meaningful to people with aphasia. This informed the conversation topics for the VESFA treatment [32].
Phase 3 | Programme theory and intervention specification	**Design and refine the intervention.** Generate content, format and delivery with stakeholders. Refine the intervention in an iterative process	The Lived Experience Advisory Group developed aspects of the intervention, experienced a taster VESFA session and give feedback. The intervention was reviewed by the author team after the first 8 weeks of the VESFA feasibility trial.
	Articulate programme theory. Articulate the theory, inputs actions that lead to the outcomes and impact (logic model)	A logic model and Template for better Intervention Description and Replication (TIDieR) description were outlined.
	End the development phase. Describe the intervention so that it can be delivered by individuals outside of the project team. Write up the intervention development process	The intervention development stage was completed when the VESFA treatment was specified and the VESFA therapy manual was produced.

Items in grey are not described in this report.

The outcomes of this development process were an intervention reasonably expected to improve functional language, described in detail in a treatment specification and available in an intervention manual.

Phase 1 | desk research

Review published research evidence

Methods

Phase 1 involved desk-based literature searching and synthesis. Both systematic review and narrative review methods were used. The VESFA intervention aimed to refine existing treatment protocols to create an intervention that addressed both word retrieval and word use in situated conversations. The word retrieval therapy with perhaps the most comprehensive evidence base is Semantic Feature Analysis, a semantic cueing therapy. The treatment asks a series of questions about the meaning of a word (its category, use, action, location, properties and associations) and elicits naming attempts [16]. A systematic review of SFA synthesised findings from 55 participants [17], the potential core components have been discussed [34,35] and gains have been replicated. VESFA drew on the Elaborated Semantic Feature Analysis (ESFA) protocol [18], an SFA elaboration where the words generated in therapy are also produced in a phrase. This version was selected to support functional word use, as the phrases practiced could be used in conversations. To address word use in conversation, VESFA drew on the conversation therapy of Marshall and colleagues [11]. In a response to the call to situate language treatments in functional situations [9,36] VESFA was delivered in the virtual environment, EVA Park. A systematic review of the use of virtual reality in aphasia rehabilitation was carried out before the intervention development [31]. This section reviewing published research evidence, therefore, outlines the evidence for virtual reality for aphasia rehabilitation, ESFA, and situated conversation therapy.

Additionally, VESFA therapy activities drew on the evidence for the use of reflection and feedback in rehabilitation: the reflection was based on Positive Psychology research [37]; the feedback provided was based on the research for Metacognitive Therapy [38]. The VESFA regimen was based on the highest quality current evidence for aphasia therapy dose [39]. Thus, a narrative review of positive psychology, metacognitive therapy and therapy dose is also shared in this section.

Results

Virtual reality in aphasia rehabilitation. A systematic review explored the use of virtual reality for aphasia rehabilitation [31]. Of the 14 studies included, 12 addressed language rehabilitation aims, 1 addressed communication activity and 1 addressed wellbeing. The literature suggested that virtual spaces have particular benefit in addressing communication activity [10,11,40] and yet they are not often used for this purpose. The VESFA intervention set out to address this - to use virtual worlds to practice situated language for functional language gain.

ESFA. Evidence for ESFA is from a waitlist randomised controlled trial [18]. Two versions of ESFA were evaluated: individual therapy ($n = 22$) and a combination of individual and group therapy ($n = 14$). Outcome measures captured naming, functional communication, wellbeing and quality of life. Results demonstrated a significant improvement in naming for the ESFA group compared with the control group with a large effect size ($p = 0.003$, $\eta_p^2 = 0.21$) and encouraging improvements on the measure of quality of life ($p = 0.015$; $\eta_p^2 = 0.11$). No significant difference was found between therapy type (individual therapy versus a combination of individual and group therapy), even with respect to functional communication. This is an interesting finding. The authors had expected an increased benefit of group delivery. However, the group described was highly structured, much like an individual ESFA session with others present, with little opportunity for naturalistic conversations. Is it possible that opportunities for conversation with ESFA might further benefit communication. VESFA accordingly was designed to include both individual SFA sessions and group conversation sessions, in which participants could employ their practised words.

Situated conversation therapy. EVA Park was developed with the aim of creating a simulated environment that would allow people with aphasia to practice real-world communication tasks in a safe space before attempting them in the 'wild'. Evidence for this approach is a feasibility randomised control trial [11] in which twenty people with aphasia received 5 weeks of conversation treatment. Participants met a communication support worker for an hour every day (total 20 h). They set functional goals and practiced conversations in the simulated environment, for example asking for a hair cut in the barber shop. This quasi-randomised group study had a waitlist design, 10 participants received the intervention immediately and 10 received the intervention after a 5-week delay. Outcomes demonstrated good compliance with the intervention with no participants lost to follow up and participants receiving, on average, 88% of the intended dose. The intervention demonstrated a significant improvement on a measure of functional communication and a significant difference between the intervention and control groups ($p = 0.034$, $\eta_p^2 = 0.225$). Nested interview and human computer interaction studies investigating the experience of receiving therapy *via* a virtual world demonstrated the intervention was acceptable and enjoyable [41,42]. Although the numbers were small, these indicative findings suggest that situated functional conversations in multi-user virtual world improved functional communication and are enjoyable, acceptable and feasible.

The potential to use EVA Park for group interventions was tested in a feasibility study of social support groups delivered online in EVA Park [14]. Thirty-four people with aphasia joined one of four groups for a 6 month intervention of fortnightly sessions in a waitlist controlled trial. Feasibility outcomes were good; 72.34% of those eligible elected to take part, 85.3% of the participants completed the intervention and 79.4% completed all testing. Participants received 81.6% of the intended dose. Preliminary outcomes were explored but there was no indication of change to wellbeing or language. The authors note that the study was not powered to detect change, but suggest that the lack of indicative benefit may call for a more intensive regimen. This study demonstrated that it is possible to run groups of 8 people with aphasia in a multi-user virtual world. Groups were therefore included in the VESFA programme with a more intense regimen.

Positive psychology interventions. Positive psychology is the study of positive experiences and positive personal traits that allow individuals to flourish [37]. It asks 'what is right?' instead of 'what is wrong?'. There is now a large body of evidence for positive psychology interventions, with six meta-analyses published over the last 10 years (see [43] for a summary). Evidence for using positive psychology approaches is outlined in a recent synthesis of 347 studies (over 72,000 participants). The synthesis demonstrated small to medium effects in a number of domains

including wellbeing, quality of life and reduced stress and depression [43]. Positive Psychology Interventions are many and can be delivered on their own or as multi-element interventions. They include practicing gratitude, practising forgiveness, identifying and using signature strengths, solution focussed coaching, appreciating nature, humour through recalling funny things and encouraging a state of flow, a state of intense, focussed concentration where self-consciousness is lost and the experience of time is distorted [44].

Positive Psychology approaches underlie some interventions for people with aphasia, specifically those that identify how to live well with aphasia [44–50]. These include identifying and using signature strengths [51] regulating emotions by drawing on positivity, determination and gratitude [52], and exploring flow [44].

In an early review of positive psychology interventions, 'Three Good Things' showed the biggest gains [53]. In this intervention participants wrote three good things every day and why they were good. This gratitude practice has demonstrated gains on the happiness index [53,54] and was adapted as a reflection activity in the VESFA treatment. At the end of each VESFA group participants were encouraged to identify what was going well. The prompt for this activity used the wording from Solution Focussed Brief Therapy, 'what were you pleased to notice?' [55].

Metacognitive therapy. Metacognitive therapy is used to increase self-awareness, self-reliance and develop compensatory strategies [38]. It increases client's awareness of their errors and teaches them strategies to manage them, with the aim that they can notice and manage them independently. A recent review found only five studies with participants with aphasia that used metacognitive therapy [38], which suggests limited use. The outcomes synthesis was unclear, with approximately half the participants improving. However, the review only included studies where metacognition was the primary outcome. Aphasia treatments often increase self-awareness and develop strategies to produce independence [56,57], and feedback from clinicians is a source of motivation [58] and often an aid in understanding a problem and how to address it but may not be labelled as metacognitive therapy. It is likely this review did not capture the full extent of the use of metacognitive strategies in aphasia therapy.

The VESFA protocol specified the use of explicit strategies to support a task across VESFA sessions. Recall of the carrier sentence was encouraged in conversation sessions. The description of a word by using the features from the SFA task was encouraged as a strategy if the word itself could not be named. The reason is twofold; it could self-cue and it could cue the listener. Both these strategies engage metacognitive skills. They require the participant to see the need for the sentence or the features strategy and use the sentence or features practiced at the relevant time. In addition, rationales were given for session activities and specific feedback was given to highlight the strategies employed that worked well. For example, it was explained that the description of a word is a useful strategy if you cannot think of the word. Phrases developed in the ESFA session were used to share stories in the group conversations.

Dose. Dose describes how much of a therapy is given. The term comes from drugs trials but is also used in complex behavioural interventions where dose is harder to define. A recent individual participant data network meta-analysis described interventions in terms of intensity (hours/week), dosage (total hours), frequency (days/week), and duration (weeks). The individual data of 959 participants from 25 randomised controlled aphasia rehabilitation trials revealed the optimal dosage by outcome [39]. The greatest gains for overall language, as measured by the Western Aphasia Battery Aphasia Quotient, were seen with a dose of 20-50 h of therapy, and a frequency of 3–5+ days/week. Therefore, the VESFA intervention aimed to fall within this range.

A review exploring dose in SFA interventions found that treatment duration ranged from 2 to 12 weeks, sessions per week from 2 to 4 sessions, and length of sessions from 45 min to 2 h [17]. All included studies were of a single case design. Higher doses had better outcomes. In low dose interventions (315–729 min, approx. 5–12 h) almost all participants improved when naming words that had been practised in therapy, but not un-practised words. In high dose interventions (1260–1470 min, 21–24.5 h) all participants made gains on treated items and in addition 9/10 participants generalised gains to untreated items [17]. This adds to the argument for total dose of >20 h and suggests that gains spread with a larger dose. Harvey and colleagues similarly suggested 'functional communication may have a higher threshold to show an effect of treatment due to increased demands on multiple levels of linguistic processing and cognitive skills' (p. 2555) in their meta-analysis of dose [59].

Drawing on the reviewed literature, potential VESFA treatment regimens that met criteria of a total dose of 20–50 h, over 3–5 days per week were presented to the stakeholders with aphasia for consultation.

Draw on existing theories

Methods

Relevant theories were drawn through consultation with domain experts, research team discussion and relevant literature. The core elements of VESFA - retrieval of words and use of words in situated conversations - were based on published theories of language, communication and learning. Specifically, they were based on theories that describe how behaviour affects the neural language network (Hebbian Learning), how language is processed (the hub and spokes model of semantic processing and the spreading activation theory), how communication functions in everyday life (the framework for situated language use), and how we learn new skills (scaffolded tasks and social cognitive theory). These theories are described here.

Results

Hebbian Learning and neuroplasticity. The principle of Hebbian learning was summarised as 'what fires together, wires together'. Hebb (1949) proposed that if a neuron B is repeatedly activated immediately after neuron A, then, over time, activating A will activate B [60]. Behaviourally this means that practice of a specific task improves performance of that task because the neural firing becomes more efficient over time. The principles of neuroplasticity expand on this concept to outline the conditions that optimise the reorganisation of neural networks [61]. These principles are derived from animal studies. Further work explored these in the context of aphasia research to identify six principles of neuroplasticity in the rehabilitation of aphasia [62]:

1. Use, improve, or lose it.
2. Specificity rebuilds targeted networks.
3. Salience is essential.
4. Repetition and intensity promote learning and consolidation.
5. Promote generalisation, avoid interference.
6. Complexity enhances learning and generalisation.

The VESFA intervention was designed with these principles in mind. The repeated practice of word production in the context of related items was hypothesised to strengthen the networks that link semantically related items, in line with Hebbian learning (principles 1,2 & 4). For example, thinking about the properties of a food term, such as 'peach', should activate connections to related terms, such as 'nectarine'. The use of the target words in the conversation context was included to promote generalisation and provide practice in the complexity of real world communication (principles 5 and 6). In conversation groups participants were invited to share stories from their own lives within the target topic e.g. on the travel topic 'tell us where you went the last time you travelled'. Sharing personal experiences ensured the target conversations were salient (principle 3). The novelty of the EVA Park environment also provides salience.

A model of semantic processing. The cognitive-linguistic model of language processing visualised the pathways and cognitive components involved in the recognition of word meaning (comprehension) and the production of words (expression) *via* a diagram of boxes and arrows [63]. It represented the steps to understand a word by hearing sound, recognising it as a known word, and accessing its semantics. It also depicted steps to produce a word from semantics, accessing a phonological plan and producing the word. However, this model gave no detail of what happens within semantic processing. How semantic knowledge is stored is described by the hub and spokes model of semantic processing [64,65].

The model proposes that each semantic representation is made up of a modality-independent core concept (the hub) and its associated modality specific features (the spokes). The core knowledge of for example an apple is seated in the 'hub', and its features (e.g. its colour, smell, texture, the actions/verbs associated with it, and linguistic label) are the 'spokes' connected to the concept. This model proposes that semantic representations, our semantic knowledge, are made up of multi-modal connected networks.

The hypothesised structure of the hub and spoke model is supported by data from people with aphasia and those with semantic dementia [66]. These show that people with aphasia and semantic dementia both exhibit problems in naming and comprehending words, which may be comparable in terms of severity. However, patterns vary across the groups. For example, people with aphasia are often helped to name an object with semantic or phonological cues, whereas those with semantic dementia are not. This suggests that a semantic deficit in aphasia is due to damage to the spokes. You can prod the system with various cues, and you will get to the core concept. This is in contrast to a semantic dementia where the hub is damaged, and cues do not help [66]. Hence, in the individual sessions of the VESFA intervention the SFA task is used to name a target word and its related features (supra-ordinate category, action, properties, location, personal association). This systematically activates the spokes around a core concept. The principle of Hebbian learning suggest that such repeated activation of the spokes and, thereby, the hub will strengthen these neural networks.

This model explains how a core concept is represented but not the path from the semantics to the word. This is explained by spreading activation theory.

Spreading activation theory. Spreading activation theory describes how we produce a target word through a process of spreading activation (Dell, 1986). Activation, the spark along the neural network, begins at the semantic concept and spreads, like water running down channels, to activate the word and then the phonemes needed to produce the word. Some spreading activation is delivered to related words that share features with the target, potentially generating naming errors. Within this theory, correct word production relies on the contribution of semantic control [67]. Such control is defined as the precise activation of semantic features and the inhibition of related items, so ensuring that the target word gains ascendancy over potential errors.

In the VESFA intervention target words were named in every session and specific features of the words are discussed. The treatment should therefore enhance target activation and promote semantic control.

Framework for situated language use. The model for situated language use describes how using language in a natural context, such as everyday conversations, is a more complex task than using language in an isolated cognitive linguistic task such as naming a picture [36]. Situated language is *interactive*, *multi-modal* and takes account of different *contexts* [9]. Taking each of these concepts in turn, conversations are interactive because they involve two or more people who react to each other and the previous conversation turn. Conversations are multimodal because the meaning is derived from facial expression, gesture, intonation as well as the words used. Conversations have a number of contexts; there is the conversational context (what has been said already within this conversation), cognitive context (what you know this person knows already) and environmental context (where you are, what you can both see). Situated language is therefore complex. Neuroplasticity research advises that complex tasks may generalise to simpler tasks, but simple tasks will not generalise to complex ones [68]. This suggests that working on word production in isolation, as occurs in pure SFA, will not generalise to a complex task such as conversation. Therefore, situated language should be targeted in treatment if a change to situated language is what is hoped for [69].

VESFA includes group conversation in a related virtual context; for example, conversations about food and drink can occur in the virtual café, conversations about gardening can occur in the virtual greenhouse. This simulates the complexity of real world situated language: navigating multiple people in a related environmental context. It is hypothesised that situating conversation in the simulated environment of EVA Park can achieve more complexity than a conventional treatment setting.

Learning theories: zone of proximal development. Writing in the early twentieth century about learning, Vygotsky proposed that child learners had a Zone of Proximal Development. This represented the space beyond what someone could learn by themselves, the potential someone could gain with support from a knowledgeable other. People can be supported into this learning space by 'scaffolding'.

Scaffolding has been used beyond child development in the fields of learning disabilities [70], cognitive therapies [71] and communication support in aphasia [72]. In VESFA, the concept of scaffolding is used in the conversation groups *via* activities of stepped complexity. The first activity is to remember the words worked on that week, a recall task that requires participants to give a single noun response. The second activity is to describe these words in the game 'Articulate', where a word is described without saying the word itself. These activities serve to activate the core vocabulary for the next task [73,74]. The third activity is a topic-based conversation. Here participants share something about themselves on the

topic of the group. This is the least scaffolded and most complex of the activities in the group. The final activity increases the scaffolding again. This involves a bingo game in which participants name pictures of the target vocabulary. Thus, the open conversation is sandwiched by more supported activities.

Learning theories: Social cognitive theory. Social cognitive theory (SCT) [75] proposes that learning occurs in a social context in the intersection between behaviours, reactions and interactions. Essentially, we learn from doing the task ourselves, watching others do a task and talking about it. The SCT includes the concept of self-efficacy. This is a person's belief that they can achieve the task in hand. There are a number of influences on self-efficacy. That you have done it before feeds the belief that you can do it again (mastery experiences), that you see someone else do it supports the belief that you can do it (vicarious experience), that others believe you can do it persuades you of your capability (social persuasion) and a positive mood influences your belief that you can do it (physiological arousal and effective states) [76]. Setting treatment in a group brings these positive social influences to learning.

There is some evidence that self-efficacy is relevant to stroke rehabilitation. For example, stroke survivors who rated themselves highly for self-efficacy achieved better rehabilitation outcomes than those with lower ratings [77]; and see [78] for a review of self-efficacy in stroke self-management). Applications in aphasia rehabilitation are rare, although SCT was cited as an underpinning theory for one aphasia group intervention [23].

In VESFA, target words are practiced in group conversations to situate the retrieval in a relevant context but also to place learning in a social context. Stepped tasks and supported conversations [79] aim to create a space for participants to experience communication success. Observing others share stories from their lives gives vicarious experience. Feedback from peers supports members to share stories. EVA Park provides a safe environment in which to gain self-efficacy. The risk of failure is less than in the real world, there is no 'loss of face', and exchanges are experienced as playful and fun [41,42].

Phase 2 | involvement

Involve stakeholders

A draft therapy protocol was developed based on the literature and underlying theory. This was shared with the stakeholders with aphasia who were consulted on therapy content, a therapy regimen, and strengths and weaknesses of the proposed sessions. The SLTs ratified the resulting treatment protocol. The VESFA stakeholder involvement had four aims:

1. To refine the goals and content of VESFA intervention in response to PWA and specialist SLT opinion.
2. To develop acceptable intervention procedures: intervention activities and intervention dose.
3. To explore the delivery of VESFA in the virtual environment.
4. To consider how this treatment approach can be integrated and implemented into clinical practice.

Methods

Two stakeholder groups were identified 1) people with aphasia to represent people who would receive the intervention and 2) speech and language therapists (SLTs) to represent people who deliver speech and language therapy interventions. Individuals with relevant experience of EVA Park and knowledge of living with or treating aphasia were invited. The stakeholders with aphasia were the trial Lived Experience Advisory Group (LEAG). They took part in three intervention development workshops. Aphasia specialist SLTs took part in one online discussion aimed at understanding how the VESFA treatment approach could be integrated and implemented into clinical practice. As a public involvement activity, where people were involved in planning and advising on research, no formal ethical approval was sought (see NIHR briefing note five). However, ethical principles were maintained; invitation emails outlined the scope of the work (how many workshops on what topic and of what length), the role of an advisory committee member and its distinction from research participant was discussed, travel costs were covered, contribution was given to recognise time and expertise, and the demands of involvement were considered (length of workshops, refreshments). Explicit consent was gained (verbal consent for the recordings used for note taking and written consent for video used to create a public facing video).

In all, seven stakeholders were consulted, four people with aphasia and three specialist clinicians. The LEAG were four men with aphasia, who were all more than 9 years post stroke, and all had experience of EVA Park. One member had previous experience as an advisor for research. The SLTs were all experts in aphasia, qualified for 15 years or more, with previous experience of delivering treatments in EVA Park.

Each of the three workshops discussed a topic: Content, Regimen, and Experience. They were led by an SLT researcher with experience of working with stakeholders to develop health solutions, author ND. Some items required a decision (the regime; the time given to naming tasks or conversation tasks) and other items required the generation of ideas (content of the conversation groups). A consensus process was used where discussion elicited ideas on a topic, then relevant literature was presented and considered and then the LEAG ideas were revisited and a majority decision checked. Discussions were supported by pen and paper activities e.g. manipulation of activities on post it notes on a framework of keep, change or avoid, see Image 1. Workshops were held at City, University of London in Jan–Feb 2020, see Table 2. Workshops were chosen to support a participatory, problem-solving approach where information flowed both from LEAG members to the researcher and from the researcher to the members. Workshops have been defined as an arrangement where 'a group of people learn, acquire new knowledge, perform creative problem-solving' (Ørngreen and Levinsen, 2017, p.71). This two-way, iterative approach allowed LEAG members to generate ideas on a topic and the researcher to share related existing literature and ideas to be revisited. The workshops were video recorded.

The SLT discussion was held online in October 2020. SLTs were invited who were experts in working with people with aphasia and had experience delivering intervention in EVA Park. The discussion was led by a topic guide had two parts. First, SLTs shared experiences of context-based language interventions to understand current clinical context. Then the researcher gave an overview of the VESFA intervention and SLTs gave feedback on the planned work. The focus group was recorded, and the discussion transcribed.

Results

Therapy content. In workshop one, the LEAG generated what activities worked well in group interventions they had attended both face to face and in EVA Park, see Image 1. Items suggested by in the workshop that were taken forward to the protocol were that groups should be led by a facilitator and should be topic based. Role play was a positive activity but should not be used in the first few sessions. They agreed it was acceptable to meet online,

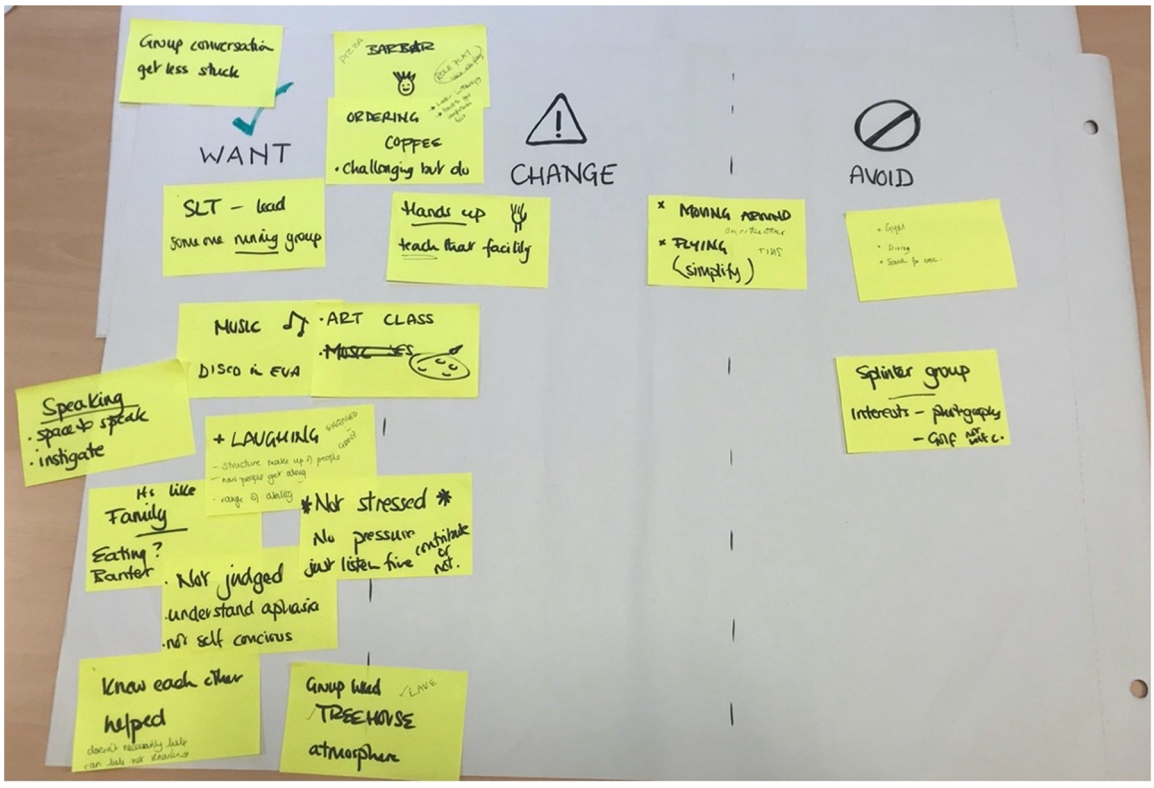

Image 1. Stakeholders with aphasia indicated therapy content to want, change or avoid by placing post it notes on a framework.

Table 2. Lived experience advisory group workshops.

Workshop 1: Content City, University of London January 2020	What goes into the therapy? Explored and charted the content of group therapy Explored priorities for therapy
Workshop 2: Regimen City, University of London January 2020	How is the therapy delivered? Explored delivery of assessment and treatment regimens
Workshop 3: Experience City, University of London February 2020	People with aphasia experienced a taster VESFA session Feedback on a taster VESFA session

and a face to face 'meet and greet' before the remote sessions was not necessary. The LEAG highlighted things that should be included to facilitate delivery in the virtual world, such as simplifying movement in EVA Park and teaching the 'hands up' function which flags when a user in EVA Park wants to talk. As a result, early VESFA sessions were planned close to where users logged in to reduce the need for avatar movement. The LEAG also highlighted things to avoid, such as not splitting the group up into subgroups and so group sizes were kept small. Items suggested that were not taken forward were those that posed practical difficulties in a virtual word, or represented personal interests e.g. golf.

Consensus was reached on the division of time to naming activities and conversation activities in the VESFA therapy protocol. The LEAG agreed that equal sessions should be given to both and the VESFA protocol offers 2 individual (naming) and 2 groups (conversation) per week. Accessible versions of relevant literature was share [80,81] and, after considering it, the group maintained that equal sessions should be assigned to both.

Therapy regimen. The second workshop consulted on 1) testing session parameters and 2) how to deliver a treatment dose of 20-50 h. It was agreed that testing sessions were acceptable at a maximum of 2 h, and this was used as the maximum testing session length in the subsequent feasibility trial. Discussion about the therapy regimen focussed on other life commitments and their relationship to time post stroke. The LEAG felt that daily intervention sessions were difficult to accommodate with other life commitments. However, if participants were newly discharged home from hospital, then daily sessions might be desirable. The Someone Who Isn't Me (SWIM) technique (see [82]) was used to get a wider set of views. LEAG members identified another person with aphasia and considered what regimen they might choose. Three potential treatment regimens were presented, e.g. 5 sessions a week for 6 weeks for a total of 36 h, see Image 2. Consensus was reached on a distributed regimen of 4 sessions a week (frequency) over 8 weeks. Each week would have two 60 min ESFA sessions and two 90 min groups (5 h a week, intensity). Total hours of therapy would be 40 (dose).

Experience. In the third workshop the LEAG experienced a taster VESFA session in EVA Park and completed a feedback questionnaire (adapted from [42]) Responses highlighted that navigating in EVA Park was challenging for some participants and should be kept to a minimum in early sessions. Group size should be a maximum of four participants, to allow time for all to participate. Comments from the LEAG highlighted that word retrieval in conversation was more challenging than word retrieval in an ESFA picture naming task. There was a discussion about positive challenge e.g. asking for a coffee in the EVA Park coffee shop made one member anxious, but they felt it was a good thing to practise. The LEAG agreed that providing opportunities for situated conversations was a strength of the proposed VESFA protocol because being in the virtual greenhouse primed gardening words. Negative comments focussed on technical aspects of EVA Park; learning to walk and fly around the island, issues with sound and hardware e.g. not having headphones.

Understanding the context. SLTs took part in a focus group to understand the clinical context. SLTs shared their experience of

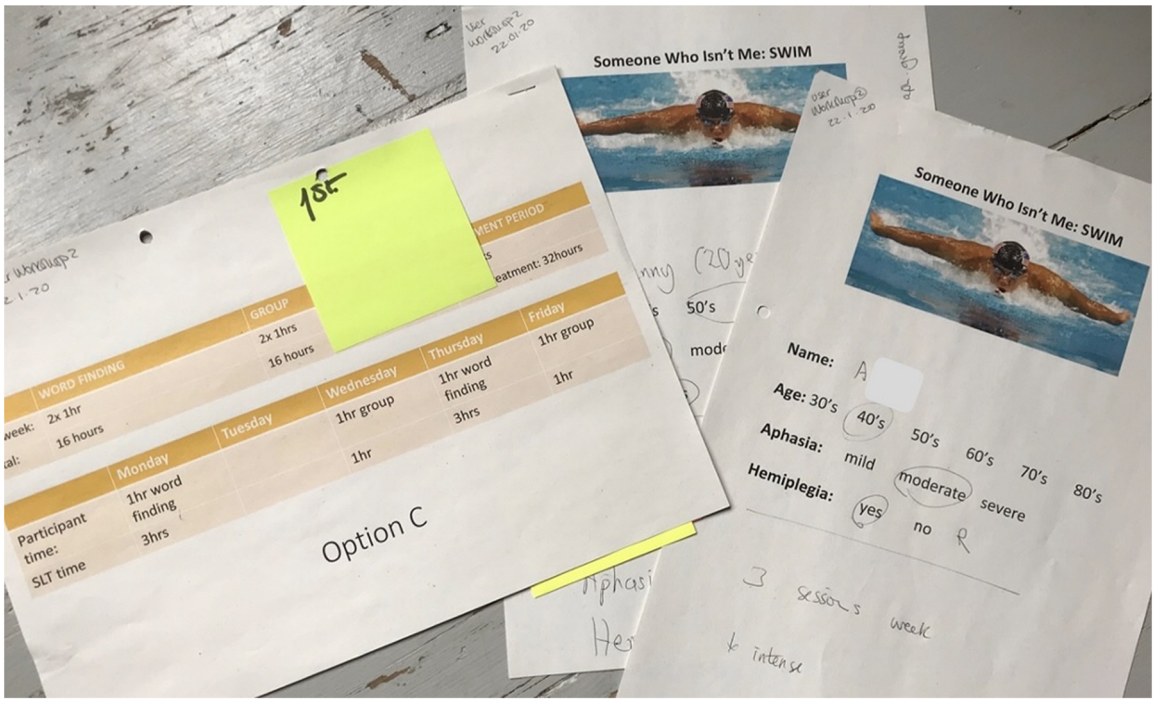

Image 2. Materials from workshop 2 showing one of the regimen options and prompt sheets used to consider Someone Who Isn't Me.

delivering situated language therapy in current practice. They discussed aspects of the situated therapies that could translate to virtual world therapies. The clinicians were presented with the planned VESFA protocol and discussed the feasibility of running the protocol within their clinical settings (NHS, private and research clinic).

The SLTs were asked about their experience of working on language in context. Context-based language in *individual* therapy interventions included taking clients to functional settings in the community (coffee shops, swimming pools, fitness centres). Context-based language in *conversational* interventions included conversation partner training (CPT) with family members in their homes. Context-based language in *group* interventions addressed life participation goals such as attendance at a concert or a pub night. With the exception of CPT, these examples come from private practice or charity run groups. There is potentially a need for context-based therapies that can be delivered in NHS settings.

SLTs considered implementation. They reported biggest challenge in running aphasia groups was the logistics of arranging people to come together for the groups. This can be particularly difficult in rural settings where a large geographical area has reduced public transport. VESFA would address this challenge. VESFA using EVA Park could be implemented in independent practice without adjustments. The model of individual sessions plus a group was reported to work well in one independent aphasia clinic. In NHS services, SLTs suggested there might be a need to consider varying cyber security rules across different NHS trusts.

Phase 3 | programme theory and intervention specification

Articulate programme theory

A logic model [83] of the VESFA intervention was constructed to demonstrate how the actions of the intervention were underpinned by theory and had expected outcomes and long-term impacts. 'Programme theory' outlines the mechanisms through which the programme is expected to drive change [84]. Understanding the theory underpinning a programme allows for evidence-based hypotheses and can lead to more successful interventions [85]. Theory also underpins intervention testing. For example, hypotheses about the drivers of change can be tested in studies that systematically manipulate treatment variables (Figure 1).

VESFA defined

The VESFA therapy was designed through a review of published evidence, describing the underlying theories, creating a logic model and a process of public involvement with stakeholders. It is an 8-week intervention delivered in the virtual world, EVA Park, that targets word retrieval in ESFA tasks and situated conversations. Participants receive 4 sessions per week: 2×60-min individual ESFA sessions, see Supplemental Material S1, and 2×90-min conversation groups, see Supplemental Material S2. Three people with aphasia receive the treatment concurrently to allow for conversation groups of three people with the speech and language therapist. Therapy stimuli consist of four conversation topics with thirty nouns in each. The words chosen for inclusion in therapy were nouns with good naming agreement. They were drawn from literature that described what people with aphasia want to talk about [32,86–88]. The most complex items from each topic were chosen, i.e., those with the lowest imageability ratings. Words were selected from databases to ensure that naming agreement and imageability ratings were available [89–91]. One topic was targeted for two weeks (four individual and four group sessions). To exemplify, a participant would work on the travel vocabulary for two weeks. In the 1:1 session they would retrieve travel vocabulary e.g. *backpack*, with its related verbs and adjectives, and connected life stories. The following day the participant would join the conversation group at the virtual campfire where they would recap their travel words practiced to date and share their

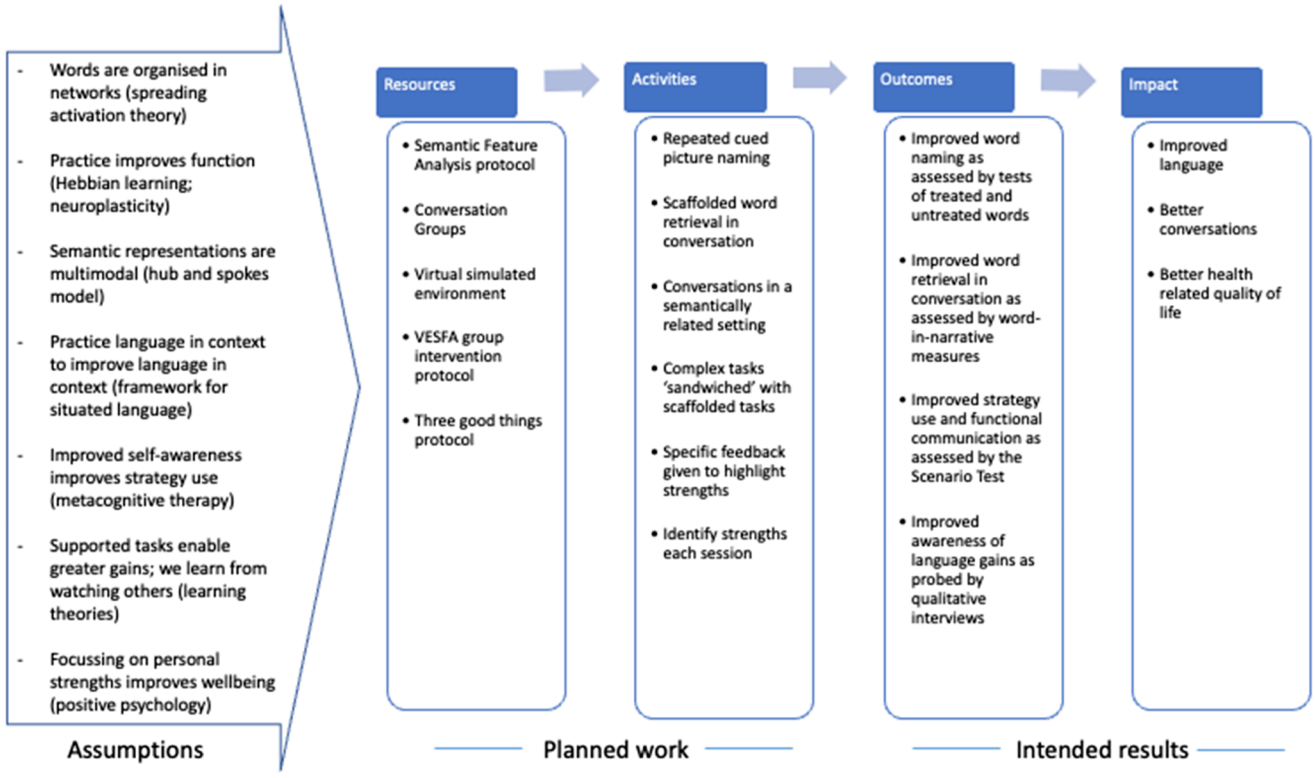

Figure 1. VESFA logic model.

travel stories in the group. For example, a memory was shared of inter-railing around Europe with backpack at 19 years old.

Refining the intervention

The VESFA intervention was tested in a feasibility randomised controlled trial. After the first three participants had finished the 8-week treatment, the study team (ND, JM and KH) reviewed the intervention protocol. The ESFA sessions worked well, and no changes were made. Adjustments were made to the groups. The participants were more engaged in activities that were scaffolded than the open conversation and groups often finished 15 min early. The word description game 'Articulate!' was added to the beginning of the group session. In this game someone describes a word without saying the word e.g. "This is part of the landscape, it is tall and often rocky, we climb or hike on it" (mountain). This activity was well aligned with semantic feature analysis as the features can be used as clues. It also primed the vocabulary that was used in the conversations. Specific feedback was also added after each task. The treatment review highlighted the need for more consistent, specific feedback to participants after their turn in the Bingo and conversation tasks. The feedback aimed to highlight the target words successfully retrieved or the strategies that worked well. The manual (available *via* Figshare.com), the treatment specifications (Supplemental Material S1 and S2) the TIDieR intervention description (Supplemental Material S3) include these added tasks.

End the development phase

The intervention development ended with the production of a treatment specification, a TiDieR treatment description [92], a logic model and the VESFA Therapy Manual.

Discussion

The VESFA intervention was developed using a theory and evidence-based approach and involvement with stakeholders. Outcomes were a VESFA treatment specification, TIDieR description and a VESFA intervention manual. The development process drew on underlying theories and existing evidence and specified what activities were reasonably expected to drive change.

The existing evidence for SFA and EVA Park interventions can be plotted onto the MRC framework. SFA has a clear underlying theoretical basis, a growing body of evidence comprising good single case studies (phase I), small group evidence, two randomised controlled efficacy trials (phase II) [18], (Kendall et al. 2019), and a systematic review and meta-analysis demonstrating 80% of participants who receive SFA improve, albeit with a small effect size [17]. Evidence for EVA Park interventions includes single case studies (phase I) and exploratory small group-controlled studies (phase II). Thus, taking these interventions forward builds on known evidence.

The rationale for articulating the theories behind an intervention is outlined in the intervention development literature [1,29,30]. Articulating the theory can support clinicians to understand the underlying mechanisms of interventions such as SFA. Belief that an intervention will work, clinical self-efficacy, is known to support competence [93]. In addition, extensive use of theory has been linked to larger effect sizes [94]. Understanding the theory behind an intervention can help us to reflect on outcomes, e.g. are patterns consistent with the theory? If positive change is not achieved, going back to the theory may help to explain why. Treatment outcomes may also throw new light on the theory or even invite modifications to it. Thus, clearly defined underlying theory may lead to more competent delivery, larger effect sizes and support evaluation.

Defining what components of an intervention lead to which outcomes is a gap in the aphasia rehabilitation literature [95].

Understanding the mechanisms of an intervention leads to clear hypotheses about its effects. In VESFA, we can reasonably hypothesise an improvement in words treated. Research arguing that the whole semantic network is strengthened through SFA tasks [16] and evidence of generalisation in the literature [17,34] can lead us to hypothesise that an independent naming measure of untreated words should also show improvement. Treating word retrieval within situated conversations leads us to hypothesise an improvement in word retrieval in discourse. Finally, the positive psychology activities [43] and wellbeing benefits of group participation and learning [77,96] can lead us to hypothesise an improvement in mood and quality of life as a result of the VESFA intervention.

Strengths and limitations

The use of research frameworks is a strength of this intervention development. The MRC framework supports researchers to reduce research waste and increase the likelihood of an effective intervention by ensuring interventions tested have a good grounding in theory, have considered implementation from the start and are based in the needs of key stakeholders.

There is a growing body of literature where people with aphasia act as consultants, advisors or partners in research [20,82,97,98] and this is increasingly a requirement by funding bodies [99]. The LEAG made key decisions in the planning of the project, they experienced a session and gave advice. Additionally, although not reported here, they interpreted the results of the subsequent phase II trial and highlighted the important findings. Their involvement can be described as 'co-thinkers and advisors in planning execution and interpretation' [100]. A limitation is that they were not 'partners' e.g. they did not co-analyse or co-write. The logic model could be strengthened by the application of behaviour change theory (BCT) [101] and theoretical domains framework [102] to underpin the actions. BCT identifies the requirements for change and the corresponding intervention functions to target those changes and may offer novel insights for therapy. There was limited representation in the LEAG, despite a more diverse group being invited, those that were able to do the workshops were all white men.

Future research

The next phase of the MRC framework is to test the intervention in a phase II feasibility trial, and this has been done (VESFA feasibility trial paper is in preparation).

Future work should also consider dose articulation: systematically testing the minimum and maximum dose parameters (Dalton et al. 2019). Work could be done to identify the optimal dose for tailored groups i.e., aphasia severity may moderate response and therefore require a higher dose. The manipulation of treatment components in efficacy studies could explore which are essential to outcomes.

Conclusion

The VESFA intervention is a complex, speech and language therapy intervention for people with aphasia that targets word retrieval in isolation and word retrieval in functional conversations situated in simulated environments. It builds on existing empirical treatment research, theory, and stakeholder views to exploit the ecological validity of the virtual world setting. The ingredients that drive the treatment outcomes have been articulated in a treatment specification and the therapy process is available in a manual.

Acknowledgements

Authors would like to thank all the stakeholders who shared their experiences and offered ideas and solutions, and City University of London and the British Aphasiology Society.

Disclosure statement

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

Funding

The intervention development work was funded by a School of Health Sciences doctoral studentship from City University of London. A British Aphasiology Society small grant funded the costs associated with convening a Lived Experience Advisory Group.

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