An investigation into the effect of a novel non-linguistic cognitive intervention on functional communication in global aphasia

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Declaration

I, Sharon K. Adjei-Nicol confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed

Abstract

Background: Global aphasia is a severe communication disorder affecting all language modalities, commonly caused by stroke. Evidence as to whether the functional communication of people with global aphasia (PwGA) can improve after speech and language therapy is limited and conflicting. This is partly because cognition is essential for successful functional communication and in global aphasia it can be severely impaired. Cognitive treatments aimed at improving functional communication in people with aphasia exist, but few have been trialled with PwGA and none have robustly demonstrated gains. This study explored the effect of a novel cognitive intervention on the functional communication skills of PwGA.

Method: A survey investigated the practices, challenges and research priorities of UK based speech and language therapists. Intervention for PwGA was found to commonly target choice-making or non-verbal communication. However, co-occurring cognitive difficulties were reported to limit progress and present a challenge when engaging clients.

Synthesising these findings with a review of the literature, a non-linguistic intervention targeting the cognitive skills underpinning functional communication was developed and delivered to six participants (recruited from NHS and independent neurorehabilitation services), three times weekly for up to 6 weeks. A multiple baseline case series design investigated changes in functional communication (as measured by a proxy rating of communication independence and quality, and a new scenario-based observational tool), cognition and auditory comprehension.

Results: Participants completed this novel intervention programme in an average of nine sessions. Five out of six participants made significant gains in functional communication as measured by a proxy, and non-verbal semantics. Auditory comprehension also significantly improved in two individuals.

Conclusion: There is preliminary evidence that this intervention can improve functional communication in some PwGA. Findings add to the evidence that cognition is critical to functional communication and highlight the benefit of treating cognition via non-linguistic means in PwGA.

Impact Statement

Stroke is the most common cause of long term disability in the UK and worldwide. Aphasia is a condition which refers to an acquired loss or impairment of language function, affecting comprehension, expression, reading and writing. This can have a negative impact on family, social relationships and employment and lead to social isolation, depression and anxiety. Global aphasia is the most severe and disabling form of aphasia affecting all language modalities and in some cases cognition also. Yet, it has had the least attention within aphasia research and rehabilitation. The aim of speech and language therapy (SLT) is to improve language and/or everyday communication skills, often referred to as functional communication. There is evidence that people with milder forms of aphasia make improvements after SLT and that cognition plays an important part in their ability to compensate for their aphasia by using other forms of communication. In contrast, only a few studies have reported language gains in global aphasia, and fewer still have demonstrated positive functional communication outcomes. Those that have reported improvements delivered a dose of intervention incompatible with most UK clinical settings and no study to date has robustly explored the impact of cognitive deficits in this client group.

This study is the first to investigate the duration, type and intensity of SLT being provided to people with global aphasia (PwGA) in the UK. At stage 1, a survey was used to obtain information on service provision and the challenges and research priorities of speech and language therapists (SaLTs) who work with this population. PwGA were reported to have difficulty accessing and benefitting from SLT, with the severity of their cognitive and linguistic impairments amongst the challenges. Findings highlighted a need for well-designed intervention studies of global aphasia.

A novel non-linguistic intervention was designed and tested during Stage 2 of this study using a series of single participant case studies. The intervention required no language to complete and was therefore accessible to PwGA despite the severity of their impairments. Furthermore, the intervention targeted the cognitive skills hypothesised to underpin functional communication. Functional outcome measures targeted independence and quality of functional communication as rated by a relative or friend and using a novel scenario-based observational tool developed for the study. In addition, changes in non-verbal cognitive skills and auditory comprehension were also investigated.

The findings provide new insights into the ability of PwGA to benefit from SLT. Five out of six participants made significant gains in measures of functional communication independence and quality (as rated by a significant other), and visual semantics in the form of gesture to picture matching and picture categorisation. This supports existing evidence that cognition underpins functional communication and rehabilitation gains in this area. Findings also have the potential to inform future SLT training and practice. Improvements were achieved with a dose of intervention that is replicable in clinical practice. This is a unique finding which contrasts with existing evidence suggesting that improvements in global aphasia are only achieved after intensive or prolonged input over many years. In summary, the findings of this study call for the creation of a new narrative on prognosis in global aphasia and have important implications for PwGA and their families, researchers, and clinicians in the field.

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For Mum and Dad

Glossary of Abbreviations

AAC	Alternative augmentative communication
ADP	Aphasia Diagnostic Profiles
APT	Attention Process Training
ASHA-FACS	American Speech and Hearing Association Functional Assessment of Communication
AST	Aphasia Screening Test
ATP	Attention Training Programme
BASA	Boston Assessment of Severe Aphasia
BDAE	Boston Diagnostic Aphasia Examination
BNVRT	Butt Non-Verbal Reasoning Test
CADL	Communication Activities of Daily Living
CAT	Comprehensive Aphasia Test
CCPT	Conners' Continuous Performance Test
CDP	Communication Disability Profile
CEBM	Centre for Evidence-Based Medicine
CETI	Communication Effectiveness Index
CI	Communication Independence
CLQT	Cognitive Linguistic Quick Test
COAST	Communication Outcomes After Stroke Scale
COBAGA	Cognitive Test Battery for Global Aphasia
FCP	Functional Communication Profile
GANBA	Global Aphasic Neuropsychological Battery
ICC	Intra class correlation
LARK-2	Language Activity Resource Kit 2
MCA	Mental Capacity Act

MCID	Minimally clinically important difference
MCST-A	Multimodal Communication Screening Task for Persons with Aphasia
MCT	Multimodal communication treatment
MDT	Multi-disciplinary team
MIT	Melodic intonation therapy
NVAFA	Nonverbal Visual Assessment of Flexibility in Aphasia
OT	Occupational Therapy
PACE	Promoting Aphasics' Communication Effectiveness
PASAT	Paced Auditory Serial Addition Task
PIC	Participant Identification Centre
PICA	Porch Index of Communicative Ability
PPT	Pyramids and Palm Trees Test
PwA	People with aphasia
PwGA	People with global aphasia
PwSA	People with severe aphasia
QC	Qualitative Communication
RCPM	Raven's Coloured Progressive Matrices
SAQOL	Stroke and Aphasia Quality of life Scale
SLT	Speech and language therapy
SaLT	Speech and language therapist
TBI	Traumatic brain injury
UCL	University College London
UK	United Kingdom
VAT	Visual Action Therapy
WAB	Western Aphasia Battery
WAB-R	Western Aphasia Battery revised
WCST	Wisconsin Card Sorting Test

WCST-64	Wisconsin Card Sorting Test-64 card version
WEST	Weighted Statistics

1 Introduction

Aphasia is a condition which refers to an acquired loss or impairment of language function, affecting comprehension, expression, reading and writing. Approximately 152,000 strokes occur per year in the UK and 33% of people who have a stroke will experience aphasia (Stroke Association, 2017). Aphasia is often classified into sub-types based on language profiles and a major differentiation is made between fluent and non-fluent aphasias. Global aphasia (a non-fluent form) is the most severe and disabling of all the aphasia sub-types. A widely accepted definition is that it is “a severe acquired impairment of communicative ability across all language modalities where often no single communicative modality is strikingly better than another” (Collins, 1986, p.6). Usually there is a distinction between the terms severe and global aphasia, with severe aphasia being used to describe severe impairments in one modality only (commonly, expressive language). However, some authors and studies have used the term severe aphasia to include those with global aphasia (see for example Parr, 2004; Nagaratnam & McNeil, 1999; Darrigrand et al., 2011).

There are few imaging studies exploring global aphasia, and the few that do exist explore rare, atypical presentations such as global aphasia without hemiparesis (see for example Pai, Krishnan, Prashanth, & Rao, 2011; Keyserling, Naujokat, Niemann, Huber, & Thron, 1997). Commonly, global aphasia occurs with contralateral hemiparesis after large perisylvian lesions in the territory of left middle cerebral artery. Ferro (1992) found the most common damage involves either anterior-posterior cortical and subcortical structures, or the anterior and superior division of the middle cerebral artery with lesser damage sub-cortically. Lesions affecting only the sub-cortex or posterior and parietal branches of the middle cerebral artery have also been found to lead to global aphasia (Ferro, 1992; Keyserling et al., 1997).

No information exists on the prevalence of global aphasia. In 1986, Collins estimated rates to be between 10% and 30% of post-stroke aphasia cases, however with medical advances such as the use of thrombolysis in acute stroke, rates may have fallen. There have been no recent investigations into the prevalence of global aphasia. There is some evidence that global aphasia occurs more frequently in women than in men (Hier, Yoon, Mohr, Price, & Wolf, 1994). Of those presenting with acute global aphasia, some will progress to less severe forms within 6 months to 1 year (Sarno & Levita, 1981; Ferro, 1992; Mark, Thomas, & Berndt, 1992) whilst in others global aphasia will persist, becoming chronic global aphasia. The exact proportion of people with chronic global aphasia is unclear. Ferro (1992) in an analysis of the CT scans of 54 PwGA, concluded that in those with more extensive damage and subsequently more severe language disturbance, chronic global aphasia was more likely to persist. In contrast, those with anterior or sub-cortical damage, or global aphasia without hemiparesis had more favourable outcomes. However, Mark et al. (1992) in a study of 13 PwGA found no clear relationship between aphasia recovery and lesion. Instead they concluded that initial Western Aphasia Battery (WAB) aphasia quotient (Kertesz, 1982) that is initial aphasia severity, is the best predictor of recovery.

Cognitive deficits, particularly in the domains of attention and executive functions have been found to occur alongside language difficulties in aphasia (Kalbe, Reinhold, Brand, Markowitsch, & Kessler, 2005; Helm-Estabrooks, 2002; Rende, 2000). In global aphasia, there have only been anecdotal descriptions and a few studies of non-verbal cognitive deficits. For example: Collins (1986, p.6) suggested that "visual nonverbal problem-solving abilities are often severely depressed as well and are usually compatible with language performance", and Van Mourik, Verschaeve, Boon, & Paquier (1992) found deficits in attention, visual and auditory recognition memory in some PwGA. Cognition has been found to be an important factor for overall functional outcome (El Hachioui et al., 2014), to predict effectiveness of therapy (Seniów, Litwin, & Leśniak, 2009) and correlate with successful functional communication (Fridriksson, Nettles, Davis, Morrow, & Montgomery, 2006). Due to these links, cognitive interventions aimed at improving language or functional communication skills have been trialled with people with aphasia (PwA) (see for example Helm-Estabrooks, Connor, & Albert, 2000; Ramsberger, 2005) and some success has been reported. However, these studies have not included PwGA and cognitive interventions suitable for this client group have not been described.

Few treatment studies of global aphasia exist generally. The lack of research may in part be due to difficulties assessing this client group, given the severity of their impairments. Another issue may be the influence of historic views about the benefit of treatment in PwGA. For example, they have been described as having "irreversible aphasic syndrome" and of being unable to make functional gains after intervention (Schuell, Jenkins, & Jimenez-Pabon, 1964, p.191). Due to the perception of poor prognosis, Marshall (1987a, 1987b) and others have argued that those with the condition should not be prioritised for speech and language therapy (SLT) and instead resources should be directed to those with milder forms of aphasia. However, the early intervention studies that contributed to these negative views were based on restoration of language. In the last few decades aphasia rehabilitation has sought to combine restorative and functional interventions, and chronic and more severe forms of aphasia are now routinely treated via a compensatory approach (see for example; Caute, Pring, Cocks, Cruice, Best & Marshall, 2013; Beukelman, Hux, Dietz, McKelvey, & Weissling, 2015). However, robust evidence that compensatory approaches can be of benefit in global aphasia are sparse. This is because only a few studies of compensatory approaches have included those with the condition, and only limited success at a functional level has been reported (see for example McCall, Shelton, Weinrich, & Cox, 2000; Ho, Weiss, Garrett, & Lloyd, 2005). Consequently, many still assume that prognosis in global aphasia is poor (Nagaratnam & McNeil 1999; Munro & Siyambalapitiya, 2016).

In summary, global aphasia is the most severe form of aphasia and is significantly under-researched. When global aphasia persists, prognosis appears poor and to date there is little evidence that those with the condition can benefit from restorative language or compensatory intervention approaches. Severe cognitive deficits may contribute both to poor prognosis and poor response to treatment, but these deficits have yet to be clearly described or investigated. There is an urgent need for research in global aphasia. Of particular interest is whether functional communication gains can be made in this population when intervention is appropriately designed and tailored to their needs.

This thesis will investigate the effect of a novel non-linguistic cognitive intervention on functional communication in global aphasia.

Chapter 2 will describe the clinical characteristics of global aphasia and the challenges of assessment before critically reviewing intervention studies, highlighting the important part cognition plays in positive outcomes. The chapter will then explore cognitive deficits in aphasia. Chapter 3 describes a survey conducted with UK based SaLTs which investigated: assessment and intervention practices, clinical challenges, and research priorities in global aphasia. Chapter 4 will describe the process of developing a new intervention and outcome measure for use in the intervention study. Chapter 5 will provide a description of the intervention study methodology and results are reported in Chapter 6. Results are discussed in Chapter 7 with consideration of the new knowledge that has arisen from the findings and future implications.

2 Literature review

2.1 Introduction

Global aphasia is diagnosed when severe impairments are displayed across all language modalities, that is comprehension, expression, reading and writing. Section 2.2 details the characteristics of global aphasia. The challenges of assessment in this population are discussed in Section 2.3. Section 2.4 describes interventions that have been tested with PwGA, drawing out commonalities such as dose and the influence of cognition. The chapter then turns to focus on cognition in Section 2.5. Firstly, the nature of cognitive deficits in aphasia and the relationship between aphasia severity and cognitive impairment are explored. Then, Section 2.5.1 reviews cognitive assessments that have been used in aphasia and their suitability for global aphasia. The cognitive rehabilitation approaches used in acquired neurological conditions are discussed in Section 2.5.2. and following this studies that have treated cognition with the aim of improving language or communication are described in Section 2.5.3. The chapter concludes with a summary of findings in Section 2.6.

2.2 Characteristics of global aphasia

There are very few descriptions of global aphasia in the literature. Anecdotal reports and descriptions suggest a variety of residual abilities exist amongst those diagnosed with the condition. However, the condition is generally characterised by a paucity of spoken expression, severely impaired comprehension and severe reading and writing impairments. Comprehension has been suggested to be the most variable domain (Mark et al., 1992). For example, some have been reported to have difficulties understanding single words or to make errors when pointing at common objects on request (Collins, 1986), while others are able to follow whole body commands and understand personally relevant questions and conversations (Goodglass, 1981; Goodglass, Kaplan, & Brand, 1983). There are also reports of PwGA being able to match words to objects or places on a map (Wapner & Gardner, 1979).

Whilst comprehension abilities vary, spoken expression is consistently poor (Mark et al., 1992). Apraxia of speech frequently co-occurs in global aphasia and contributes to difficulties in spoken expression (Goodglass, Kaplan, & Barresi, 2001). Some individuals have no spoken expression, however more commonly verbal output is restricted to automatic speech, a few stereotypical utterances or repetitive syllables (Goodglass et al., 1983; Keyserling et al., 1997). Neologisms are also common (Morrow-Odom & Swann, 2013) but intonation and rate of speech may be appropriate (Keyserling et al., 1997). Repetition abilities vary, with some individuals demonstrating significant impairment (Keyserling et al., 1997), while others are able to repeat a small number of single words and phrases (Collins, 1986). So, whilst some with global aphasia have a degree of verbal output, the ability to use words or phrases functionally is reported to be consistently poor and the general consensus is that PwGA have little to no functional spoken language abilities.

Reading abilities are at least as impaired as auditory comprehension and verbal expression (Keyserling et al., 1997). Difficulties have been reported with matching letters, matching common written words to pictures and reading personally relevant single words (Ho et al., 2005; McCall et al., 2000; Schuell et al., 1964). Some PwGA have residual writing abilities and are able to write personally familiar information such as their name (see for example a case study by Morrow-Odom & Swann, 2013). However, others have difficulty copying simple shapes and letters (Schuell et al., 1964).

Some researchers have attempted to distinguish between those PwGA who have relatively spared functional communication and cognitive skills, and those who do not. For example, Garrett and Beukelman (1998, p.469) described those with impaired cognitive skills alongside language as “Basic-Choice Communicators”, that is having “profound cognitive-linguistic disorders across modalities”, significant difficulty in initiating basic communication, and in responding to conversational input and non-verbal signals. By contrast, they describe “Controlled Situation Communicators” as having impaired linguistic skills but better cognitive abilities, with the ability to initiate communication acts, participate in routine conversations with familiar others, and indicate needs by spontaneous pointing (Garrett & Beukelman, 1998, p.469).

Another functional communication distinction is drawn by Lasker & Garrett (2006), based on communication partner dependency when using alternative augmentative communication (AAC). They differentiate between “partner dependent communicators” who require cueing or assistance to utilise strategies and “independent communicators” who can access and utilise strategies without assistance (p.218). Although neither Garrett and Beukelman (1998) nor Lasker & Garrett (2006) are explicit about the relevance of specific aspects of cognition with respect to categories of global aphasia, their descriptions suggest the potential existence of severe executive function deficits in initiation, planning, problem solving and reasoning.

In summary, descriptions of global aphasia are few in number and often limited to single case studies carried out some time ago. However, it is generally agreed that all language domains are severely impaired. There has been some suggestion that cognition may be as severely affected as language in some individuals with global aphasia, and some researchers have linked spared cognition to independent use of AAC and to the existence of some level of functional communication.

2.3 The challenge of assessing global aphasia

Standardised assessment of aphasia should enable important aspects of an individual's language functioning to be determined, including: communicative strengths and weaknesses, target areas for treatment planning, and the degree of improvement or regression over time (Ivanova & Hallowell, 2013). Gaining such information in global aphasia can be challenging because many existing standardised language assessments and functional measures have complex instructions, high task demands and low face validity.

Many assessments do not contain tasks that are sufficiently basic to provide information about residual skills in global aphasia. With the exception of the AST (Whurr, 2011), few assessments assess basic comprehension or verbal expression such as single word to object matching or automatic speech, and none include assessment of gestural comprehension. Instead relatively complex tasks such as: listening to a story and answering questions, written lexical decision, reading and answering questions on a case history form, free conversation and composite picture descriptions are often used. Such tasks are far beyond the level of those with global aphasia. Subsequently, most PwGA score at floor and little or no information on their residual skills is obtained. The inclusion of basic language tasks would allow residual skills to be understood and small subtle changes over time to be captured.

A further issue is the majority of commonly used aphasia language batteries assess comprehension and expression through the use of pictures. For example the WAB-Revised (WAB-R; Kertesz, 2006), Boston Diagnostic Aphasia Examination (BDAE-3; Goodglass et al., 2001), Aphasia Diagnostic Profiles (ADP; Helm-Estabrooks, 1992), and Comprehensive Aphasia Test (CAT; Swinburn, Porter, & Howard, 2004) all do this. The PwA is given a target word or sentence and must point to a picture that matches this from an array of options. If the PwA fails, it is assumed that auditory comprehension deficits are the cause. Heuer & Hallowell (2007, 2009) are amongst those who suggest that incorrect responses may be due to the influence of stimulus-driven aspects, such as colour, size or familiarity of the depicted concepts. They also draw attention to the non-linguistic skills required to complete such assessments, namely visual memory, visual attention, object recognition, semantics and visual search skills. This raises questions about face validity. Tasks are purported to assess one language domain, but concomitant non-linguistic cognitive impairments could confound findings and alternative explanations for failure or errors are possible. This has important implications for the assessment of global aphasia where cognitive deficits may be more severe.

Assessment or screening of skills such as visual attention, visual perception, object recognition and semantics would be useful for understanding any concomitant cognitive deficits that are present in global aphasia. This is supported by the findings of Moerkerke & Verwilligen (2016) who interviewed six SaLTs who had trialled the Boston Assessment of Severe Aphasia (BASA; Helm-Estabrooks, Ramsberger, Morgan, & Nicholas, 1989) with 10 PwGA. The BASA (Helm-Estabrooks et al., 1989) is not widely used in the UK but was designed specifically for people who have limited verbal output. The SaLTs in Moerkerke & Verwilligen's (2016) study reported that the lack of inclusion of a non-verbal semantic task or screen of pre-semantic skills in this assessment limits is usefulness in global aphasia. The Pyramids and Palm Trees Test (PPT; Howard & Patterson, 1992) is a commonly used assessment of non-verbal semantics that could be useful for understanding non-verbal semantic abilities, and a modified and abridged version is also contained within the CAT (Swinburn et al., 2004). However, the instructions for these types of non-verbal semantic tasks can be linguistically complex and successful completion relies on pre-semantic skills such as object recognition and visual selective attention. For example, in the picture version of the test, the PwA must look between three pictures or words (a stimulus, target and distractor), recognise them, understand their meaning, disregard the distractor and point to the picture or word best connected with the stimulus. In terms of assessing pre-semantic skills, of well-known assessments only the Porch Index of Communicative Ability (PICA; Porch, 1967) and AST (Whurr, 2011) assess skills such as visual perception and object recognition. The PICA (Porch, 1967) although outdated and no longer in regular use, contains a task requiring the matching of identical objects. The AST (Whurr, 2011) has a sub-section on visual perception and visual recognition, including tasks such as matching identical colours, shapes, letters, numbers and objects to pictures.

Many commonly used functional and quality of life assessments are similarly incapable of drawing out useful information in global aphasia. For example, the Functional Communication Profile (FCP; Sarno, 1969) and Communication Activities of Daily Living (CADL; Holland, 1980, CADL-2; Holland, Frattali, & Fromm, 1999) include linguistically complex questions that are also abstract in nature such as “Do you live in a house or an apartment?”, Can you describe it for me?” or “What kind of work have you done?”. The CADL (Holland, 1980) and CADL-2 (Holland et al., 1999) also include role play situations such as being at the doctor’s office or at restaurant and asking the PwA what they would do or say in a specific situation. Such tasks would be difficult for PwGA to complete given the complexity of instructions and abstract nature (being unrelated to the here and now). In addition, the assessments which use role-play do not measure real life communicative performance, instead the PwA's potential in real life is inferred from performance in a simulated scenario. Yet, this may not be equivalent to real life communicative performance. It has been suggested that directly observing a PwA in real life communication situations or gaining reports from others about actual communication situations are superior ways of assessing functional communication (see Houghton, Towey, & Pettit, 1982; Lomas et al., 1989) and particularly beneficial in those with more severe forms of aphasia (Manochiopinig, Sheard, & Reed, 1992). The Edinburgh Functional Communication Profile (Skinner, Wirz, Thompson, & Davidson, 1984) is an assessment that could be useful to this end. It assesses the presence of specific communicative behaviours such as greeting, acknowledging, responding, requesting, and initiation of communication within an observed natural conversation. However, the assessment has not been psychometrically tested or used in research studies.

Quality of life assessments explore how speech and language difficulties affect social and family life. Commonly used tools include the Communication Disability Profile (CDP; Swinburn & Byng, 2006), The Living with Aphasia: Framework for Outcome Measurement (Kagan et al., 2008), Stroke and Aphasia Quality of Life Scale (SAQOL; Hilari, Byng, Lamping, & Smith, 2003) and Communication Outcomes after Stroke Scale (COAST; Long, Hesketh, & Bowen, 2009). However, they all assess quality of life through questionnaires and rating scales which may be difficult for PwGA to complete and additionally, the abstract concepts explored may be difficult for PwGA to understand. Assessments such as the SAQOL (Hilari et al., 2003) have been described as "communicatively inaccessible" for people with severe aphasia by authors such as Simmons-Mackie et al. (2014). A specific criticism of both functional and quality of life assessments is that the communication situations explored are too advanced to be relevant to the daily life of someone with severe communication deficits (Houghton et al., 1982). For example, tools such as the CDP (Swinburn & Byng, 2006) and Communication Effectiveness Index (CETI; Lomas et al., 1989) assess abilities such as following a newspaper headline, participating in group conversation, talking on the phone, and saying names which would be beyond the capabilities of most PwGA. One assessment that considers basic communication relevant to PwGA is the Multimodal Communication Screening Task for Persons with Aphasia (MCST-A; Garrett & Lasker, 2005). The tool was designed to determine candidacy for AAC in global aphasia and assesses ability to relay messages such as hunger, tiredness or wanting a light turned on, using symbols or pictures. However, this tool is specific to AAC and not used as an assessment of functional communication more broadly, neither has it been psychometrically tested. Inclusion of basic communication behaviours within functional communication assessments would be beneficial for use in global aphasia. Of existing functional communication measures, only the American Speech and Hearing Association Functional Assessment of Communication (ASHA-FACS; Frattali, Thompson, Holland, Wohl, & Ferketic, 1995) attempts this with skills such as recognising familiar faces, understanding facial expressions, understanding tone of voice, answering yes/no questions and making wants and needs known included. In addition, the ASHA-FACS (Frattali et al., 1995) measures qualitative communication parameters such as the promptness and appropriateness of communication and how much of a burden the communication partner carries. These are highly relevant factors to consider in people with severe aphasias (see Section 2.2 p.22 whereby Lasker & Garrett (2006) differentiate between PwGA based on communication partner dependency). It is possible that with intervention, the degree of communication partner dependency may reduce in PwGA, yet this parameter is not measured in most tools. Whilst the ASHA-FACS (Frattali et al., 1995) is potentially beneficial for use in global aphasia, it requires a proxy (SaLT or significant other) familiar with the PwA to rate communication behaviours and as such may be subject to rater bias.

In summary, the majority of existing assessment tools either do not contain tasks that can provide information on residual skills or are insensitive to small changes in global aphasia. Instructions can be complex and pre-semantic skills such as visual perception are rarely assessed. Yet, these skills are important pre-requisites for successful completion of assessment tasks. Communication partner burden has rarely been considered and neither have the skills relevant to the everyday lives of PwGA. Of the tools discussed, the AST (Whurr, 2011) and ASHA-FACS (Frattali et al., 1995) appear to provide the best opportunity to meaningfully assess global aphasia. The ASHA-FACS (Frattali et al., 1995) will be used as the primary outcome measure in the main study of this thesis. Due to the lack of a suitable direct measure of functional communication a new assessment will also be designed.

Difficulties in assessing and measuring change in global aphasia may account for the limited number of intervention studies in the field. The following section will review existing studies.

2.4 Intervention in global aphasia

Few treatment studies of global aphasia have been conducted and fewer still have robustly demonstrated gains. Many have significant methodological flaws or constitute low quality evidence, being single case studies. Due to the paucity of evidence available, in the following section relevant intervention studies in severe aphasia will be described alongside those of global aphasia. Three main themes are highlighted: the significant dosage required to achieve improvements, the limited evidence of functional gains, and the possible contribution of cognition to positive outcomes.

The findings of some studies suggest PwGA are unable to make any meaningful gains after intervention. Schuell et al. (1964) were the first to report this, based on the outcome of language stimulation treatment delivered to four PwGA. The language stimulation approach involves impairment-based tasks such as repeating words and phrases, naming pictures, completing phrases, word associations, reading in unison and spelling. They found that the four participants made small improvements in areas such as auditory comprehension but did not maintain these gains once intervention ended, and neither were any improvements made in functional speech, reading or writing. However, statistical analyses were not attempted, and neither was any evidence provided to support their claim that clients deteriorate once intervention ends. A somewhat negative view of outcomes in global aphasia pervaded for many years after this study (see for example, Marshall, 1987a, 1987b; Peach, 2001) and may explain the limited research in this field.

However, in practice today, language stimulation and indeed impairment based intervention more broadly is rarely used with people with more severe forms of aphasia. Instead compensatory based approaches are favoured, such as drawing (Sacchett, Byng, Marshall, & Pound, 1999; Sacchett & Lindsay, 2013) writing (Beeson, Rising, & Volk, 2003; Beeson, Higginson, & Rising, 2013), gesture (Caute et al., 2013; Marshall et al., 2013; Marshall, Best, Cocks, Cruice, & Pring, 2012) and use of AAC (Jacobs, Drew, Ogletree, & Pierce, 2004). The majority of studies of compensatory based treatments have targeted severe aphasia, not global aphasia. Salis & Edwards (2015) suggest that approaches that have been designed for use with severe aphasia such as the writing treatment described by Beeson et al. (2013) could be adapted for use in global aphasia. However, there are few examples in the literature of successful adaptations such as this or of successful use of AAC in global aphasia. For example, McCall et al. (2000) were unable to elicit improvements in the functional use of an AAC programme (known as C-VIC) in a client with global aphasia after delivering targeted intervention three times a week for over 3 years. Similarly, Koul, Corwin, & Hayes (2004), found that the two participants with global aphasia in their study were unable to progress beyond the most basic level during an intervention targeting use of a computer based graphic symbol communication system called GUS. Those with severe aphasia however performed better, with some able to produce sentences of varying complexity using the system.

When PwGA have made improvements, SLT intervention has often been delivered over many years or at a high intensity. Neither of which are replicable in clinical settings. One study demonstrating this is by Denes, Perazzolo, Piani, & Piccione (1996) who measured effectiveness of SLT for 17 PwGA. Participants were on average 3 months post stroke and divided into two groups. The experimental group of eight received intensive SLT approximately daily (mean 125 sessions) and the control group of nine, a standard dose of SLT two to three times weekly (mean 60 sessions) over a 6-month period. Session duration was not specified. The intervention included auditory comprehension tasks of increasing complexity, conversational training including turn-taking, total communication, and expressive language tasks such as story re-telling. A comparison of means revealed a higher improvement in mean score for the intensive group than regular group on all sub-tests of the Aachen Aphasia Test (Huber, Poeck, & Willmes, 1984). The authors concluded that PwGA benefit from intensive therapy. However, with the exception of the written language sub-test, improvements reported were not statistically significant. Furthermore, the statistically significant improvement found for written language is a surprising finding given written language was not targeted in the intervention and may be due to spontaneous recovery given the time post onset of the participants. In a longitudinal study completed by Sarno & Levita (1981), seven PwGA were tested at 4, 8, 26 and 52 weeks post stroke using the FCP (Sarno, 1969), the BDAE-2 (Goodglass et al., 1983), the Token Test (De Renzi & Vignolo, 1962), and naming, sentence repetition and word fluency tasks and found to make gains. Over the timeframe all participants received SLT from their own SaLT but specific information on tasks and dose are not provided by the authors. Participants improved on the Token Test (De Renzi & Vignolo, 1962), varying in range from 31 to 76 points and all participants also improved in at least three of the other assessments, particularly in the latter 6 months' post stroke. Reports from individual SaLTs suggested that there was an increase in spontaneous speech (such as: the number of words used, length of short phrases and sentences, as well as increased comprehension in social conversation) for all participants by the end of the year. Whilst findings suggest that PwGA may be able to benefit from SLT if delivered for up to one year, this study is of low quality as it did not use statistical testing or control tasks as part of the design.

Evidence from single case studies also suggests PwGA make gains if provided with significant amounts of intervention for more than 6 months. Single case study evidence is of low (level 4) quality (Centre for Evidence-Based Medicine (CEBM), 2009). However, in global aphasia given the paucity of research available these are useful to aid understanding of recovery and response to intervention. Samples & Lane (1980) reported improvement on the PICA (Porch, 1967) overall score, gesture score, verbal score and graphic score in a participant with global aphasia who received intervention twice weekly for 3 months and then five times a week for 3 years. However, they do not provide information on the participant's communication profile or measure functional communication gains. Basso (2010) provided intervention 2 hours daily for an initial 3-month period and then once daily for 6 months to an individual with global aphasia. The content of the intervention which was known as "natural conversation", is not clearly described but reportedly targeted turn-taking and interaction skills. The justification provided by the author is that the intervention aimed to focus on the interaction between the clinician and the PwA. After treatment the participant made gains in object naming accuracy which improved by 50%, and sentence production which improved by 40%. Functional improvements were reported by the SaLT and the participant's wife but may be subject to bias. However, the assessment used was not specified, no control measures were used, and no statistical analyses conducted.

Smania, Gandolfi, Aglioti, Girardi, Fiaschi et al. (2010) also concluded based on a single case study of a 37 year old male with global aphasia that PwGA may benefit from longer periods of therapy. Their participant was assessed over 25 years and received SLT for 2 years (five times a week for the first 6 months and then three times weekly for 18 months). The authors found that in the first year after stroke there was significant improvement in comprehension of simple conceptualised tasks measured in the Milan Language Examination (Milan University Neuropsychology Center, 1974) such as single word to picture matching, but recovery of more abstract comprehension measured in the Token Test (De Renzi & Vignolo, 1962) took an unspecified longer duration of time to improve. However, their findings highlighted that their participant continued to improve after SLT ceased. For example, they found that repetition continued to improve over 10 years, whilst reading single words aloud emerged from 3 years onwards and continued to progressively improve. Therefore, whilst the trajectory of recovery may have been longer, SLT outcomes are uncertain especially given functional communication outcomes were not considered. The authors suggested that cognition may have played a part in the participant's trajectory of recovery citing that spared memory and attention may have been influencing factors.

In their single case study of a man with global aphasia, Ward-Lonergan & Nicholas (1995) also suggested that cognition may have played a role in positive outcomes. Their participant received treatment known as Promoting Aphasics' Communication Effectiveness (PACE; Davis & Wilcox, 1985). PACE is a barrier task that emphasises semi-natural communication, involving the SaLT and PwA as giver and sender of messages. The sender must convey the information portrayed on a picture card to the receiver (who cannot see it) using any modality available to them. The PwA then receive feedback on how successful they have been at conveying the message. After 30 weeks of one hour sessions, twice weekly, the participant was found to have made gains in auditory comprehension, improving from a score of 27 to 39 on the BASA (Helm-Estabrooks, 1989). There was no change in spontaneous speech. The participant then received a further 2 years of therapy again one hour sessions, twice weekly but this time focused on functional drawing. Towards the end of treatment, drawings were found to be more recognisable (as judged by an independent assessor) and the participant was reportedly using spontaneous gestures and (limited) writing in conjunction with drawing during sessions. Ward-Lonergan & Nicholas (1995) suggested motivation, good recall for life events, good spatial orientation and attention to detail may have impacted response to treatment.

Studies in severe aphasia have also highlighted the importance of intact cognitive skills for positive outcomes. Wallace, Purdy, & Skidmore (2014) suggested that spared cognitive skills (specifically in executive function) may explain differences in the response of two people with severe aphasia to modified multimodal communication treatment (MCT). MCT involves teaching multiple modalities (speaking, writing, gesturing and pointing to a communication board) simultaneously with the aim of improving verbal and non-verbal communication and increasing successful communicative repairs. Wallace et al. (2014) adapted MCT by including the modality of drawing and treating a smaller number of nouns and verbs than traditionally used. In treatment sessions participants were presented with a picture and asked to name, draw, write, gesture and reference the picture in a communication book. The primary outcome measure was a referential communication task which involved the participant attempting to communicate the content of a photograph to a communication partner unable to see it. The aim was for participants to use all modalities and to switch modality if their communication partner was unsuccessful at guessing the photograph. Participant 1 received 10 sessions over 16 days and reached the target criterion of accurately using three out of five modalities for at least seven target concepts. He also improved in ability to switch modality during failed communication attempts from 13.33% at baseline to 75% at follow up. Participant 2 received 14 sessions over 16 days before being discharged from hospital and failed to meet the target criterion in this time. In addition, switching attempts or use of other modalities did not improve. Wallace et al. (2014) hypothesised that semantic deficits and executive function difficulties (in initiating switching behaviour or allocating resources effectively) may have contributed to the poor outcomes for participant 2. Similarly, Purdy & Wallace (2016) proposed that the variability in outcome across three PwSA who trialled intensive MCT was due to differences in executive functioning. The three participants were seen intensively for 10 sessions over 2 weeks. Each session lasted 2-3 hours. On the same referential task as the Wallace et al. (2014) study, participants 1 and 3 acquired the means to express the target nouns in at least two modalities when presented with a picture. However, participant 2 showed minimal change. He continued to use unintelligible verbal speech and required cues and demonstrations to switch to non-verbal modalities. The variability in outcome across participants was discussed and the authors proposed that differences in baseline semantic knowledge and executive functioning may explain the different responses to the treatment. They reported that participant 2 (who did not respond to MCT) had the lowest executive function score of the three participants and a semantic deficit at baseline as measured by PPT (Howard & Patterson, 1992). The provision of semantic treatment prior to MCT for those with severe impairments in this area was suggested.

Some studies of global aphasia have treated cognition either solely or alongside language and communication, and outcomes have been positive. Visual Action Therapy (VAT; Helm-Estabrooks, Fitzpatrick, & Barresi, 1982) is a non-verbal treatment for global aphasia, designed to be conducted as a precursor to communication treatment. It works outside the modality of speech using real objects, pictures and gestures and aims to improve the desire to communicate and the ability to relay concepts through gesture. Steps in the VAT (Helm-Estabrooks et al., 1982) programme are ordered hierarchically, initially focusing on non-verbal comprehension and later non-verbal expression. Skills targeted include visual perception, visual recognition, visual semantics and gesture production. 100% success is required at each step before progressing to the next. In a study of eight PwGA, Helm-Estabrooks et al. (1982) found significant group-level improvements in gestural pantomime and auditory comprehension as measured by the PICA (Porch 1967). There was also a trend towards significant improvement in reading comprehension. The intervention was delivered for 30 minutes daily for between 4 and 14 weeks (depending on progress through the hierarchy) which, while intensive could be replicated in some clinical settings. The authors hypothesised that because the intervention is non-verbal yet led to improvements in linguistic skills, indirect training of cognition (in the form of general attention, visual spatial and visual search skills) may have underpinned the outcomes. However, they do not explore the possibility that enhanced visual search and perceptual difficulties may have contributed to better performance on the assessment. Whilst these findings are promising, Helm-Estabrooks & Albert (2004) propose the pre-requisite skills for the intervention are “good attention span”, “ability to use overlearned gestures in everyday contexts”, and “at least moderate ability to perform nonverbal cognitive tasks of memory and visual perception” (p.253). These are precisely the co-occurring cognitive impairments PwGA may have, and therefore the accessibility of this intervention for many with the condition is questionable. Furthermore, the study did not measure whether the intervention led to functional communication gains.

The lack of measure of functional gains is a frequent limitation of many studies of global aphasia. In the few studies that have demonstrated functional gains in this client group, cognition has again been treated either directly or indirectly. Ho et al. (2005) delivered supported conversation treatment using either a remnant book (depicting past events using real items) or a picture book (using photos of past events), to two PwGA. The participants were reported to have some ability to indicate yes/no and understand single words in context but could not initiate interactions spontaneously. Intervention involved the communication partner (a trained SaLT) interacting with the client using one or other type of book, asking them at least three open questions and making at least three general comments. Within the interaction, the SaLT supplemented her speech by pointing to remnants or photos and nodding to demonstrate her understanding of the participant's communication. An alternating ABA treatment design was used whereby the participants had five sessions of each treatment condition once daily over 5 days. The treatment baseline and post intervention testing involved a video recorded 5-minute unsupported conversation without a communication book. These were analysed before and after the intervention and coded for the number of conversational turns, topic initiations, communication breakdowns, instances of negative affect, no responses and pointing. The authors found that both types of books facilitated interactions but there was a modest advantage for remnant over picture books. One participant initiated more topics with the remnant book and both participants demonstrated increased joint attention and pointing with the remnant book. However, analysis was conducted by counting frequency of behaviours with no statistical analysis completed. In addition, due to the use of an alternating treatment design it is difficult to know which intervention was responsible for any gains observed. Nevertheless, there is some suggestion that the intervention trained elements of cognition. For example: initiating is an executive function skill linked to motivation and drive (Keil & Kaszniak, 2002; Powell, 2017), turn-taking requires both attention and initiation skills, topic maintenance requires sustained attention skills and repair relies on executive function skills such as self-monitoring and problem-solving (Acimovic, 2010; Malia & Brannagan, 2014; Powell, 2017).

Cognitive skills were explicitly treated alongside communication in single case studies by Lawson & Fawcus (1999) and Morrow-Odom & Swann (2013). Lawson and Fawcus's (1999) participant attended group sessions focused on total communication twice a week for 8 months. Tasks included signing, PACE (Davis & Wilcox, 1985), miming, drawing, reading and writing. Importantly, the authors reported that turn-taking, self-monitoring and self-rating were repeatedly emphasised during the sessions. After treatment, gains were reported in the use of gesture, drawing and mime in real life situations. It is possible that gains in attention and executive function, yielded through the emphasis on turn-taking, self-monitoring and self-rating may have contributed to the outcomes. However, findings from this study must be treated with caution given only subjective reports by a significant other were gathered and no control measure used. Morrow-Odom & Swann (2013) delivered cognitive tasks such as symbol cancellation, shape and symbol sequencing, alongside Melodic Intonation Therapy (MIT; Albert, Sparks, & Helm, 1973) to a participant with global aphasia. Intact auditory processing is usually a pre-requisite for using MIT (Helm-Estabrooks & Albert, 2004) but was not the case in this study. The authors' explanation for the inclusion of cognitive tasks was to disrupt the potential monotony of the 2.5 hour long sessions and reduce fatigue. They further explained that tasks did not include letters or numbers to avoid indirectly training language. They provided 32 sessions, over a 7-week period. Each session involved 90 minutes of MIT with short 5-minute breaks for cognitive tasks to be completed. After the intervention, the participant was found to have improved in performance on all sub tests of the ADP (Helm-Estabrooks, 1992). The aphasia severity standard score from the ADP (Helm-Estabrooks, 1992) was also found to have improved, but aphasia classification did not change and the participant persisted with global aphasia. Importantly, functional communication changes were captured using the ASHA-FACS (Frattali et al., 1995) and the communication independence score was found to have increased from 3.81 before the intervention to 4.21 post intervention. The participant was noted by her husband to be using more gesture in context, counting during card games and making more spontaneous production attempts after the intervention. There was no change on the SAQOL-39 (Hilari et al., 2003). The authors concluded that MIT is a suitable treatment for PwGA but did not acknowledge the influence cognition may have had on outcomes. It is possible that the cognitive training may have supported functional improvements. However, the study design makes this difficult to establish. A useful comparison would have been to also deliver MIT without the cognitive tasks.

In summary, intervention studies that have demonstrated positive outcomes in global aphasia have either delivered a high dose of therapy and/or suggested that cognition may have contributed to outcomes. Either spared cognitive skills in participants have been proposed to have influenced gains, or cognition (particularly attention and executive function skills) have been treated directly or indirectly alongside language and communication. Researchers who have studied other (milder) forms of aphasia have suggested that cognition plays a role in successful functional communication and may contribute to overall positive outcomes after SLT. The next section will explore the literature on cognition in aphasia, drawing out what is known about the relationship between cognitive deficits and aphasia.

2.5 Cognition, rehabilitation, and aphasia

It is widely accepted that there are five cognitive domains: attention, visual perception, memory, language and executive functioning. Cognition has been deemed critical to effective communication in functional contexts, participation in rehabilitation and SLT, and overall functional outcome after stroke. Helm-Estabrooks & Holland (1998, p70) state:

> "At the most basic level, therapy requires the ability to attend and concentrate and memory is critical to all learning. Integrity of visuospatial skills is needed for processing many treatment materials and finally executive skills are required if a patient is to implement and develop ways to communicate in unique situations despite their aphasia".

El Hachioui et al. (2014) demonstrated the importance of cognition to overall functional outcome after stroke. They assessed 147 participants with acute aphasia and found that those with more severe cognitive impairments (difficulties in two or more domains of visual memory, visual semantic association, visual perception and executive functioning) had a poorer functional outcome as measured by the modified Rankin scale (Bonita & Beaglehole, 1988), than those with milder cognitive impairment (difficulties in less than two of the above domains).

There is no clear understanding of how the five domains interact with each other or whether there is a hierarchical order. This makes it difficult to design cognitive interventions using a theoretically motivated model. However, attention is generally accepted to be the most basic of cognitive domains (Helm-Estabrooks & Holland, 1998; Villard & Kiran, 2017) and executive functioning is considered to be a complex cognitive process, requiring high level functioning (Rende, 2000). Evidence from neuroimaging studies suggests that specific cognitive domains are not localised to one particular region of the brain, but instead involve a network of brain regions. Three different networks relevant to cognitive processing have been identified and described by authors such as Duncan (2010) and Mineroff, Blank, Mahowald, & Fedorenko (2018). The first is the multiple demand network, involving bilateral prefrontal and parietal cortices which supports executive processes and complex cognitive tasks. Next, is a default mode network involving bilateral frontal parietal regions which are activated when internally-oriented processes occur (such as mind-wandering or reminiscing about the past). The third is a core language network involving left fronto-temporal regions. This is recruited for linguistic processing (Binder, Desai, Graves, & Conant, 2009; Mattheiss, Levinson, & Graves, 2018; Mineroff et al., 2018). Not only has the multiple demand network been found to be activated in response to a diverse range of cognitive tasks (Duncan, 2010), but Mineroff et al. (2018) found that complex language tasks may recruit both the language network and the multiple demand network, and Dick et al. (2001) found that syntactic (linguistic) processing involved activations in regions relevant to lexical semantics, memory, attention and perception. These examples suggest processing related to one cognitive domain may involve activation in a broad network of brain regions (including regions associated with other types of cognitive process). It is probable that domains of cognition are interconnected, but no interactive model encompassing all domains of cognition exists and cognitive domains have often been studied separately. This is particularly so in the literature relevant to stroke where research has focused on the domains of attention and executive function. The reason for this may be that stroke is believed to have a greater negative effect on attention and executive function than other domains such as memory (Cumming, Marshall, & Lazar, 2013).

Attention has been described as critical to all activities because failure to attend results in a failure to process information (Helm-Estabrooks 2002). Villard & Kiran (2017) further add that attention may be the most fundamental of cognitive processes because it functions as an implicit prerequisite for the successful execution of a variety of other more complex operations. They describe how language therapy presupposes an ability to maintain basic attention and that impairments in attention may have a negative impact on the success of therapy. The models of attention proposed by Sohlberg & Mateer (1987) and Posner & Petersen (1990) are the most widely reported in the literature on acquired communication disorders. Both models consider attention as a multidimensional cognitive capacity. Sohlberg & Mateer (1987) refer to five sub-categories of attention which can be applicable to visual, auditory or tactile stimuli. These are: focused attention, sustained attention, selective attention, alternating attention (also referred to as switching attention) and divided attention. Focused attention (sometimes described as the ability to orientate attention) is the ability to respond discretely to stimuli. Sustained attention is the ability to maintain a consistent behavioural response during continuous or repetitive activity and selective attention is the ability to maintain a cognitive set (sustain attention) in the presence of distractors. This requires activation and inhibition of responses. Alternating attention is described as the capacity for mental flexibility and allows for moving between tasks that have different cognitive requirements. Divided attention is the ability to simultaneously process two types of information. Posner & Petersen's (1990) model divides attention into three sub-systems which are the alertness and arousal network, orienting network and executive network. These sub-systems are thought to support different but interrelated functions such as orientating to sensory events, conscious processing and maintaining vigilance, and an alert state. The sub-systems are also reported to interact with other systems such as semantics. A commonality across both models is the suggestion that capacity is limited so resources may be flexibly allocated. Both models propose that at any one time, the greater the amount of attention that is directed towards one task, the less remains available to be directed towards other tasks.

Deficits with different types of attention have been reported in PwA and Tseng, McNeil & Milenkovic (1993) provide two possible explanations for these. One is that PwA are poor in evaluating task demands and therefore inaccurately allocate attention resources when completing tasks. Another is that PwA evaluate tasks appropriately but have an impaired ability to mobilise and distribute their attentional resources. PwA have been found to perform worse than non-neurologically impaired control participants on tests of focused attention (Robin & Rizzo, 1989), sustained attention (Glosser & Goodglass, 1990; Murray, Holland, & Beeson, 1997), selective attention (Van Mourik et al., 1992), and divided attention (Glosser and Goodglass, 1990; Erickson, Goldinger, & LaPointe, 1996). However, these studies did not explore or discuss the potential impact of such deficits. Villard & Kiran (2018) do explore this. They found that PwA experience increased fluctuations in their attention and suggest that this has significant implications for SLT and may account for negative response to treatment. They administered five computerised attention tasks (which increased in complexity in terms of number of modalities required and linguistic demands) to 18 participants with varying types and severities of aphasia, and matched controls. Tasks were completed in a random order on four occasions, and accuracy and reaction time were measured. The first two tasks were non-linguistic visual sustained and visual selective attention tasks, the third task required simultaneous visual and auditory processing, the fourth task was a lexical decision whereby a linguistic component was added, and the fifth task added a semantic component. PwA were found to demonstrate more within-session (moment to moment) variability than controls. In addition, the reaction times of PwA were found to slow as complexity of task increased. Some but not all PwA also demonstrated increased between session variability as task demand increased. The authors could not find any pattern in the profile of participants who did or did not show increased between-session variability. Whilst the above studies of attention deficits in aphasia provide useful information, the mixed group of participants used in each study make it difficult to establish attention deficits or patterns of performance specific to global aphasia.

Executive functions are reported to be the cognitive skills most vulnerable to the effects of brain damage associated with aphasia (Rende, 2000; Helm-Estabrooks, 2002; Cumming et al., 2013). This is because the blood supply for frontal language structures is shared with the dorsolateral prefrontal cortex which is an area integral to executive functions (Cumming et al., 2013; Helm-Estabrooks, 2002). There is agreement that executive functioning is a multidimensional process, consisting of several top-down or supervisory processes that enable goal-directed and adaptive behaviour. However, there is a lack of consensus as to exactly what skills are involved and how they relate to one another (Murray, 2017). Malia & Brannagan (2014) divide executive functions into seven main areas which are: self-awareness, goal setting, self-initiation, self-inhibition, planning and organising, self-monitoring and self-evaluating, and flexible problem solving (sometimes referred to as cognitive flexibility), but do not detail the relationship between these sub-domains.

Of all the areas of executive function, cognitive flexibility has gained the most attention with respect to PwA because of its relevance to functional communication. PwA have been found to have more difficulty switching behaviours than non-neurologically impaired controls. For example, Purdy (2002) assessed 15 PwA and found that they performed worse than healthy controls in terms of speed and efficiency on executive function tests such as the Porteus Maze Test (Porteus, 1959) and Tower of London (Shallice, 1982). PwA were also less accurate on the Wisconsin Card Sorting Test (WCST; Grant & Berg, 1993) (a specific assessment of cognitive flexibility). Analysis of errors and response to cues on the WCST (Grant & Berg, 1993) suggested that PwA had more difficulties initiating switching their behaviour and made more perseverative errors. However, no information is provided about types and severity of the PwA in the sample. Chiou & Kennedy (2009) completed a task called Go No-Go with 14 PwA (the majority of whom were characterised as having mild aphasia) and healthy controls. The task required the participant to respond to the command “go” by pressing a button. Conditions in the task varied. For example, the “go” command could be presented auditorily or in writing or an additional instruction could be added. These variables could be either predictable or unpredictable. PwA were found to have reduced ability to switch compared to healthy controls. In addition, PwA were slower to switch and made more errors when unpredictable variables were added. Chiou & Kennedy (2009) proposed that such difficulties may negatively affect the ability of PwA to generate different ideas to solve problems, shift from one topic to another, and use a variety of strategies when misunderstood. However, the study itself did not explore functional communication changes. Due to the samples used, the studies by Purdy (2002) and Chiou & Kennedy (2009) do not provide specific information on executive function deficits in global aphasia.

Two studies enhance understanding of cognitive deficits in global aphasia. Marinelli, Spaccavento, Craca, Marangolo, & Angelelli (2017) investigated 189 PwGA as measured by the Token Test (De Renzi & Vignolo, 1962) and Aachen Aphasia Test (Huber et al., 1984). Participants completed the Cognitive Test Battery for Global

Aphasia (CoBaGa; Maguire, Nicholas, & Zipse, 2012) which is a non-verbal battery containing five subtests that evaluate attention, executive functions, logical reasoning, memory, visual-auditory recognition and visual-spatial ability. Findings suggested the participants could be divided into three sub-groups based on their performance. One sub-group performed well across parameters and had functionally spared cognition, a second group were heterogeneous, demonstrating spared cognitive skills particularly in terms of memory but difficulties in the other areas, and a third group had severe difficulties in all cognitive parameters. This third group consisted of 39 participants who had more severe linguistic deficits than the other two groups. Van Mourik et al. (1992) have reported similar findings to Marinelli et al. (2017) and also discuss the impact cognitive deficits in global aphasia may have on SLT. They administered the Global Aphasic Neuropsychological Battery (GANBA) an assessment consisting of five tasks assessing attention, memory, visual and auditory recognition, and intelligence to 17 PwGA. Results suggested the existence of two groups. Van Mourik et al. (1992) described the first group of four PwGA as having intact basic cognitive functions (scoring above 80% on at least four of the GANBA tasks), and a larger second group of 13 as displaying variable patterns of deficits including non-verbal auditory processing difficulties, impaired concentration and a lack of basic visual skills. Van Mourik et al. (1992) hypothesise that the first group would be able to benefit from intervention targeting compensatory strategies, such as use of gesture or a communication book. On the other hand, they suggest the second group of 13 who display variable patterns of deficits may require training in these skills prior to language oriented treatment. However, they do not describe what such intervention could entail. Van Mourik et al. (1992) also describe additional unpublished data that suggests a third group exists who appear unmotivated, have little communicative intent and cannot draw, point with intent or use yes/no consistently. They propose that in this group cognitive and language assessment is impossible therefore intervention should be indirect and target communication partners and social interaction. The descriptions Marinelli et al. (2017) and Van Mourik et al. (1992) provide of their third group of participants are somewhat consistent with the group Garrett and Beukelman (1998) describe as basic choice communicators (see Section 2.2, p.22). This evidence suggests some PwGA display cognitive deficits that are as severe as their linguistic deficits, and that this combination has the potential to make assessment, participation in SLT and functional communication particularly challenging.

When the link between aphasia severity and severity of cognitive impairments has been investigated using participants with a range of aphasia types, evidence of a link is equivocal. Some report a positive relationship (Bonini & Radanovic, 2015; Murray, 2012) whilst others have found no relationship (Fucetola, Connor, Strube, & Corbetta, 2009; Hinckley & Nash, 2007; Kertesz & McCabe, 1975). However, in studies of severe and global aphasia specifically, a pattern emerges which suggests those with more severe linguistic impairments have more marked executive function deficits (see Marinelli et al., 2017). Olsson, Arvidsson, & Blom Johansson (2019) also found this. They divided 47 PwSA into two groups (verbal and non-verbal) based on their residual abilities and administered sub-tests from the Cognitive Linguistic Quick Test (CLQT; Helm-Estabrooks, 2001) as well as language and functional communication assessments (CAT, Swinburn et al., 2004; CETI, Lomas et al., 1989, The Scenario Test, Van Der Meulen, Van De Sandt-Koenderman, Duivenvoorden, & Ribbers, 2010) with each group. Olsson et al. (2019) found that the nonverbal group (that is those with more impaired verbal language) had more severe impairments of executive functions. The non-verbal group also performed worse than the verbal group on functional communication measures. In addition, their functional communication correlated with their performance on the CLQT (Helm-Estabrooks, 2001). In summary, these findings highlight a relationship between executive function and functional communication in PwSA.

As part of a systematic review, Simic, Rochon, Greco, & Martino (2019) examined whether relationships between executive functions and language therapy outcomes were linked to overall aphasia severity. Based on the findings from 15 studies, they concluded that in most studies with mild-moderate aphasia, no correlations have been found between baseline executive function and language therapy outcome, or baseline language abilities and language therapy outcome. However, in studies primarily treating moderate-severe aphasia, they concluded that positive correlations emerge whereby both executive function and language ability at baseline positively correlate with language therapy outcome.

In summary, PwA may be particularly susceptible to attention and executive function deficits, and these may negatively impact on functional communication and treatment outcomes. Evidence as to whether it is possible to predict the severity of cognitive impairments from aphasia severity is equivocal. However, in global aphasia specifically, there is evidence to suggest the existence of a sub-group with severe cognitive deficits across multiple domains consistent with their language profile. This group are likely to have substantive functional communication deficits as a result but understanding of cognitive domains and how they interact as well as the nature of attention and executive function deficits in global aphasia is limited. Given the importance of cognition to the intervention process and functional outcomes, assessment of this area is vital. It is important that any cognitive assessment of PwA does not disadvantage them given their linguistic impairments. In severe and global aphasia this is a particular challenge. The following section will explore the challenges of cognitive assessment in aphasia with focus on the issues pertinent to global aphasia.

2.5.1 Assessment of cognition in aphasia

Many cognitive assessments are unsuitable for those with severe aphasic impairments because of the complexity of instructions, task demands and low face validity (the degree to which the assessment measures what it aims to measure). This section will explore these issues and critically review the few cognitive assessments that have been designed with global aphasia in mind.

In assessment of cognition in aphasia, attempts have been made to use assessments with little linguistic demand. While the expressive language demands of responding are often minimised, relatively little thought is given to the demands on receptive language posed by task instructions, or to the underlying cognitive skills required to complete tasks. For example, line cancellation tasks and the Flanker Task (Eriksen & Eriksen, 1974) are commonly used to assess attention and visual neglect in aphasia (see Helm-Estabrooks, 2001; Marinelli et al., 2017; Geranmayeh, Brownsett, & Wise, 2014; Kluding,Tseng, & Billinger, 2011) but rely on other cognitive skills such as visual perception, which may also be impaired. In line cancellation tasks, participants are required to view a page of lines and to cross out only those that have a particular orientation. Other cancellation tasks use symbols. In the Flanker Task (Eriksen & Eriksen, 1974), participants must selectively attend to a target flanked by two non-target stimuli either congruent or incongruent with it, with the aim of selecting the target (using a button press) without being distracted by the non-target stimuli. Whilst both tasks require a non-verbal response, those with comprehension deficits may find the instructions complex and a correct response requires intact visual scanning and visual perception.

Low face validity is also demonstrated in non-verbal variations of digit span tasks which are frequently used to assess short term memory in aphasia. In the verbal form of this task, participants are required to repeat back strings of increasingly lengthy digit strings, whereas in non-verbal versions, participants must point to the correct order of digits on a card (see for example, Friedmann & Gvion, 2003). Despite being used to assess memory, successful completion of digit span tasks requires not only short term memory but visual scanning, numerical recognition and comprehension skills.

In their review of the appropriateness of executive functioning assessments for use in aphasia, Keil & Kaszniak (2002) concluded that the WCST (Grant & Berg, 1948), Raven's Coloured Progressive Matrices (RCPM; Raven, 1956) and Tower tasks such as the Tower of London (Shallice, 1982) were amongst those with high usefulness for this population. However, the authors' focus was on whether verbal output was required to complete the assessments rather than demands on comprehension. They conceded that those with comprehension deficits such as in global aphasia would still find these assessments difficult. Aside from demands on comprehension, the suggestions proposed by Keil & Kaszniak (2002) also rely on memory and/or visual perception skills. Consequently, face validity is again an issue. To take the WCST (Grant & Berg, 1948) as an example, in this assessment, an individual is presented with a set of stimulus cards and asked to sort the remaining cards but is not given further instruction on how to do this. They must ascertain the sorting rule (which could be colour, shape or number) based on feedback they are given after each trial. During the assessment, the sorting rule changes. Not only is cognitive flexibility necessary, but visual perception skills are required to sort by colour or shape, and the participant must be able to switch attention between the task and the examiner as well as remember the feedback they have been given. This assessment has been used in many studies with PwA such as Fillingham, Sage, & Ralph (2005) and Purdy (2002), however task demands are high. Fridriksson et al. (2006) found that more than half of their sample of 25 PwA could not complete a shortened version known as the WCST-64 (Kongs, Thompson, Iverson, & Heaton, 2000). Similarly, RCPM (Raven, 1956) is primarily used to assess non-verbal visual problem solving but is significantly reliant on visual perceptual skills. In the assessment participants are required to identify the missing element to complete a pattern. Whilst task requirements are relatively simple to explain and no verbal output is required to complete it, Van Mourik et al. (1992) found that 30% of their participants with global aphasia could not complete this assessment. Although non-verbal in nature, Kertesz & McCabe (1975) found that performance on the RCPM (Raven, 1956) correlated with comprehension deficits. This may partially explain the difficulties PwGA have been found to have with this assessment.

Some researchers have attempted to design cognitive batteries with low task and linguistic demands for specific use in severe or global aphasia. For example, the GANBA (Van Mourik et al.,1992) consists of five tasks to assess attention, memory, visual and auditory recognition, and intelligence. All tasks reportedly have relatively simple instructions and require only a Yes/No response. The assessment itself is unpublished and tasks are not described in detail in the 1992 publication but they include: visual matching, line cancellation (where the participant must cross out numbers embedded within letter symbols), recognition memory using objects and faces, non-linguistic auditory recognition, and an adapted version of the RCPM (Raven, 1956) whereby options are laid vertically to counteract any issues with visual neglect. The RCPM (Raven, 1956) has been found to be difficult for some PwGA. Van Mourik et al. (1992) reported unpublished data obtained from assessment of an unknown number of PwGA that demonstrated 31% of those with the condition could not complete the RCPM (Raven, 1956) and of those that could 78% scored at or below the 25th percentile.

More recently, authors such as Marinelli et al. (2017) and Maguire, Nicholas, & Zipse (2012) have considered assessments suitable for use in severe and global aphasia and have designed the CoBaGa and Nonverbal Visual Assessment of Flexibility in Aphasia (NVAFA) respectively. Both are unpublished. The CoBaGa (Marinelli et al., 2017) was designed for severe aphasia and contains five subtests that evaluate attention, executive functions, logical reasoning, memory, visual-auditory recognition, and visual-spatial ability and includes commonly used tasks such as RCPM (Raven, 1956), letter, digit and symbol cancellation, face and object recognition memory tests and visual-auditory recognition tasks. All rely on intact visual perceptual skills.

The NVAFA (Maguire et al., 2012) as revealed by its use in a feasibility trial by Nicholas & Connor (2017), requires the participant to look at an array of 15 items which are either pictured objects or abstract designs. The array is presented on ten different occasions and each time the items are arranged slightly differently. The participant is asked to circle three items that have something in common, and which are different to items in their previous response. The assessment aims to test cognitive flexibility in global aphasia. However, instructions appear complex and may be too difficult for some with the condition. Furthermore the task relies on intact short term memory, visual scanning, perception and recognition. Nicholas & Connor (2017) found that PwA had more difficulty on the picture object version than abstract design version of the task. No reasons are provided for this finding by the authors, but it suggests that semantics may play a part in successful completion of the picture object version, and highlights the assessment has low face validity.

In summary, it is difficult to objectively assess aspects of cognition in global aphasia because many tests have complex instructions and task demands or rely on additional cognitive skills such as visual scanning/searching, visual perception or semantics, which are commonly impaired in this population. Despite the prevalence of cognitive deficits in people with aphasia and the research that has been conducted assessing cognition in this population, there has been relatively little research investigating cognitive interventions. Yet as suggested by authors such as Mayer, Mitchinson, & Murray (2017), it would be useful for interventions to address non-linguistic cognitive deficits in addition to the primary language impairment. The following section will first discuss general approaches to cognitive rehabilitation before reviewing in more detail those that have been used to treat linguistic or functional communication deficits.

2.5.2 Cognitive rehabilitation

The typical goals of cognitive rehabilitation are to either re-establish previously learned behaviours or develop new behaviours to compensate for cognitive impairments and minimise the functional impact in daily life. In progressive conditions such as Parkinson's Disease or dementia however, goals may be to maintain cognitive functioning (Bahar-Fuchs, Martyr, Goh, Sabatas, & Clare, 2019; Cicerone et al., 2019). Cognitive rehabilitation approaches are often described as falling into three categories: individualised cognitive rehabilitation, cognitive stimulation and practice orientated cognitive training (Bahar-Fuchs et al., 2019; Clare & Woods, 2004).

Individualised cognitive rehabilitation is a compensatory approach that aims to reduce the impact of cognitive impairments on functional abilities by using strategies that minimise demands on a particular cognitive skill. For example, if the primary issue impacting performance on a task is an attention deficit, strategies such as taking planned rest breaks, reducing background distractions or avoiding activities when tired may be employed (Royal College of Physicians Intercollegiate Stroke Working Party, 2016). On the other hand, if the primary issue is memory, strategically placed notes, signs, diaries, calendars or personal memory books are commonly used strategies (Bourgeois & Hickey, 2009; Volkmer, 2013). Errorless learning approaches are frequently used to support clients with conditions such as Alzheimer's and vascular dementia to use memory aids (Volkmer, 2013). Compensatory strategies for executive functions include increasing self-awareness, goal setting and providing structured feedback on performance of functional tasks (Royal College of Physicians Intercollegiate Stroke Working Party, 2016). Individualised cognitive rehabilitation targets everyday tasks and situations in a real-life context and there is no implicit assumption of generalisation to other tasks or situations (Clare & Woods, 2004).

Several studies have evaluated individualised cognitive rehabilitation techniques for stroke and traumatic brain injury (TBI). One such technique is time pressure management (Dymowski, Ponsford, & Willmott, 2016). This method teaches people with TBI to recognise, prevent and manage time pressures as well as how to monitor their use of strategies, with the aim to reduce the impact of slowed speed of processing. It involves participants completing logs of the attention difficulties they encounter, learning and implementing strategies (such as chunking, repetition and use of memory aids) and self-rating their performance. Time pressure management has been found to improve speed of processing and memory in people with severe and very severe TBI (Fasotti, Kovacs, Eling, & Brouwer, 2000), and to improve independent use of strategies (Winkens, Van Heugten, Wade, Habets, & Fasotti, 2009). The use of compensatory strategies or techniques such as time pressure management often require some degree of insight or high level cognitive skills that would be inappropriate for PwGA.

Cognitive stimulation involves engagement in a range of activities and discussions (usually in a group setting) that target general enhancement of cognitive and social functioning (Clare & Woods, 2008). These include orientation, reminiscence, validation, and multi-sensory tasks. Cognitive stimulation has primarily been used in people with moderate dementia to support memory orientation and meaningful interaction. In a systematic review of 15 randomised control trials, Woods, Aguirre, Spector, & Orrell (2012) concluded that cognitive stimulation consistently produces improvements in general cognition as measured by tests such as the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975). They found that in some cases cognitive stimulation leads to positive changes in social interaction, communication and quality of life. Cognitive stimulation has been found to load heavily on verbal communication because tasks involve thinking about words, reading and using language creatively (Spector, Orrell, & Woods, 2010). Given this, considerable adaptation would be required for use in global aphasia.

The third cognitive rehabilitation approach is practice orientated cognitive training, which involves guided practice with computerised or paper and pencil tasks. Such training can address one or multiple cognitive domains. A central assumption underlying practice orientated cognitive training is that practice has the potential to improve or at least maintain functioning in the given cognitive domain (Kallio, Hietanen, Kautiainen, & Pitkälä, 2020). Furthermore, any effects of practice are expected to generalise beyond the immediate training context (Clare & Woods, 2004). Cognitive training has been found to provide limited effects in mild-moderate dementia (see Bahar-Fuchs et al., 2019, for a review). However, in stroke and TBI benefits have been found for attention, especially if practice orientated cognitive training is combined with compensatory strategy training (Cicerone et al., 2019, 2011). Computerised cognitive training has potential for use in global aphasia due to the limited linguistic demands required for the approach.

An example of practice orientated cognitive training is described in a seminal paper by Sohlberg & Mateer (1987). The computer based intervention known as attention process training (APT) contains hierarchical tasks in order of complexity based on the model of attention proposed by Sohlberg & Mateer (1987) as described in Section 2.5. (p.35), Sohlberg and Mateer (1987) trialled APT on four people with TBI. It is unclear if they had aphasia or any other communication difficulty. An outline of intervention tasks is provided but some details such as the exact stimuli used are lacking. The first task targets focused attention and requires the participant to detect auditorily presented number targets. Progressively more difficult tasks such as listening to strings of auditorily presented numbers while at the same time estimating time are introduced. Selective attention tasks involve selecting a target stimulus in the presence of either auditory or visual distractors. Complex tasks towards the end of the hierarchy include "dual tasks" whereby the participant must respond to both auditory and visual information simultaneously. The participants were assessed before and after intervention using the Paced Auditory Serial Addition Task (PASAT; Gronwall, 1977) and a visual-spatial assessment. Participants received between 4 and 8 weeks of intervention seven to nine times per week. The two participants with mild-moderate attention deficits improved to scoring within normal limits on the PASAT (Gronwall, 1977), the two who were more severely impaired improved into the mildly impaired range. Improvements were maintained at 8 months follow up for all four participants and the authors concluded that attention deficits can improve with training. However, the results were not subject to statistical testing and the participants received concurrent intervention targeting activities of daily living, psychosocial skills and vocational rehabilitation. The authors reported that participants met their clinical goals in areas such as returning to employment or living independently within the timeframe of the study. However, given these areas were treated alongside APT (Sohlberg & Mateer, 1987) it is unclear what, if any effect APT (Sohlberg & Mateer, 1987) had on this functional outcome. In addition, it is not possible to ascertain the relative contribution of each component of the training programme to the results. Neither is it possible to establish any additional understanding of the authors' model of attention. However, some tasks particularly those earlier in the hierarchical programme appear relatively simple to comprehend and require no verbal output to complete. These may be suitable for use in global aphasia.

Another example of practice orientated cognitive training that could be adapted for use in global aphasia was designed by Sturm, Willmes, Orgass, & Hartje (1997). It targets alertness and vigilance (sustained attention) as well as selective and divided attention. The alertness training task involves an animated driving task whereby the participant must control the speed of a vehicle and avoid collisions using two keys on the computer. The vigilance training task involves the participant watching objects fly across the screen or move across an assembly line on screen. They must then press a response key when sudden changes in speed, additional objects or damaged items are observed. The selective training task involves participants watching objects fly across a screen and pressing a response key only when a specific pre-determined object appears. Finally, the divided attention task involves a "flight stimulator" task in which the participant must monitor three different stimulus sources: a horizon, speed and an auditory sound. They were required to press a button if the horizon or speed moved outside a set limit while also listening out for two successive interruptions to a motor sound. The computer programme automatically adapted the level of difficulty within each task depending on performance. Task difficulty was increased if the participant scored 90% over 50 responses and reduced if errors exceeded 33%. Thirty-eight participants who had suffered a stroke and had deficits in at least two areas of attention (vigilance, selective attention or divided attention) participated. They completed treatment in the attention domain that they scored lowest in and one other randomly allocated domain. Twenty-two of the participants had suffered left hemisphere lesions and 16 had right hemisphere lesions but no information on language skills is provided. They received 14 sessions of 1 hour duration for each domain. The authors found that response time for each sub-domain improved after specific training. Additionally, there was some generalisation of skills to other sub-domains. For example, alertness training and selective attention training led to improvements in response time on more complex divided attention tasks, and alertness training led to improvements in response time on more complex selective attention tasks. These findings support the notion of a hierarchical organisation of attention functions. However, error rates which are arguably a more relevant outcome measure to consider for functional skills, only improved after treatment on the divided attention task. Furthermore, findings did not demonstrate generalisation to other cognitive domains and generalisation to everyday life was not measured.

In summary, there are three main cognitive rehabilitation approaches. Individualised cognitive rehabilitation and cognitive stimulation often load heavily on high level cognitive skills, language or both. Practice orientated cognitive training often involves computerised tasks with no linguistic component and this approach may be useful for application in global aphasia. However, limited evidence of generalisation to other cognitive domains or everyday life have been reported. Some studies have attempted to specifically investigate whether treating cognition can generalise to improvements in language or functional communication in people with aphasia. These will be described in the following section with reference to their applicability for use in global aphasia.

2.5.3 Cognitive interventions for language and communication

The cognitive intervention studies that have been conducted in aphasia have predominantly focused on the domains of attention and executive function. Key studies will be described in the following section and their appropriacy for use or adaptation in global aphasia reviewed. The discussion will highlight that many cognitive interventions have not addressed generalisation to functional communication, and those that have, have high linguistic and cognitive demands or significant methodological flaws.

Brain budget is one approach with high linguistic and cognitive demands. It targets executive functioning skills and has been used to train reading in a participant with mild-moderate receptive aphasia (Mayer et al., 2017). Brain budget uses the analogy of money (such as having a "budget" and resources "costing money") and teaches people with cognitive impairments to allocate resources appropriately to complete tasks. In the case study by Mayer et al. (2017), prior to completing a reading task, the participant was asked to predict: how much assistance would be required, whether more time to complete the task than before her stroke would be needed, and what might aid accuracy prior to completing reading tasks. After completion the participant reviewed her performance and was given support and feedback on how to allocate her attentional budget in a different way in order to improve future performances. After intervention, the participant was reportedly independently self-monitoring and using trained techniques when reading. Written and verbal expression also improved, suggesting some generalisation of gains to language, but these findings were not subject to statistical testing. The intervention would not be accessible to PwGA as it requires high level comprehension skills and spared cognitive skills such as insight, abstract thinking and problem solving.

APT-II (Sohlberg, Johnson, Paule, Raskin, & Mateer, 2001) is a practice orientated computerised cognitive training programme which also includes complex and highly linguistic attention tasks. For example, tasks include: identifying words from a list that belong to a category, paragraph listening, and completing a maths worksheet whilst monitoring time. Murray, Keeton, & Karcher (2006) delivered 30 weeks of APT-II (Sohlberg et al., 2001) three times a week to a participant with mild-moderate Wernicke's aphasia and found improvements were made on trained tasks and sub-tests of the Test of Everyday Attention (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994). However, no generalisation to language function as measured by ADP (Helm-Estabrooks, 1992) or functional communication as measured by CETI (Lomas et al., 1989) and Test of Language Competence (Wiig & Secord, 1989) were found.

VAT (Helm-Estabrooks et al., 1982) is a non-linguistic practice orientated cognitive treatment targeting visual perception, recognition, semantics and use of gesture in which indirect improvements in auditory comprehension were made in a group of PwGA (see Section 2.4, p.31). Studies have attempted to replicate this finding and have investigated whether treating a cognitive domain can lead to improvements in auditory comprehension. Salis (2012) attempted to train memory in order to improve comprehension skills in an individual with transcorticomotor aphasia who is described as "severe". The participant was treated with listening span tasks of different lengths and after intervention improved in listening spans of five monosyllabic words but performed worse on longer strings of six and seven monosyllabic words. A significant improvement on the Test of Reception of Grammar (Bishop, 1989) was also found. This suggests that treatment generalised to sentence comprehension and that treating a cognitive domain (in this case short term memory) can improve linguistic skills. However, generalisation of findings is difficult given it is single case study. Furthermore, the profile of the particular participant appears unique. Salis (2012) describes her as an atypical case of transcorticomotor because of a marked comprehension deficit and suggests the participant would be classified as global had they not had spared repetition ability. Yet, a description of the participant's verbal output provided in the study highlights expressive skills that would be beyond that of most with global aphasia. For example, the participant when describing the "cookie theft" picture from the BDAE-3 (Goodglass et al., 2001) was able to correctly label people and items in the picture and produce a meaningful two word phrase.

A practice orientated cognitive rehabilitation programme aimed at improving auditory comprehension in aphasia has been described by Helm-Estabrooks et al. (2000). Attention Training Program (ATP) is a hierarchical intervention programme based on Sohlberg & Mateer's (1987) model of attention. Tasks include cancelling target lines, trail making, memorising designs and pictures, counting, clock drawing, picture completion and categorising pictures. Despite purporting to target attention, the list of tasks suggests the programme also targets visual memory, mathematics, visual perception, semantic knowledge, and problem solving. The intervention is based on the hypothesis that attention difficulties account for some deficits in comprehension observed in PwA, such as within-subject variability and improved comprehension as a result of the manipulation of extra linguistic information such as speech rate. All tasks are non-linguistic, requiring no auditory comprehension or verbal output to complete. The authors used ATP (Helm-Estabrooks et al., 2000) to treat auditory comprehension in two clients with moderate-severe aphasia. Each participant received 17 sessions of ATP (Helm-Estabrooks et al., 2000) of unknown duration. Consistent with the findings of Helm-Estabrooks et al. (1982), ATP (Helm-Estabrooks et al., 2000) was found to improve the auditory comprehension of both clients as measured by the BDAE (Goodglass et al., 1983) despite the treatment being non-linguistic. Both clients also made substantial improvements on the RCPM (Raven, 1956) and the authors suggest this is the result of generalisation of ability from the domain of attention to non-verbal reasoning. However, the intervention appears to target cognition more broadly than is claimed. Rather than just training attention, visual perception, memory, and semantics are also treated within tasks. The findings are promising but the study has many limitations. Not only are functional gains not measured but individual's baseline scores showed improvement, making it difficult to conclude that the intervention was responsible for gains made. Furthermore, no control task was used, and outcomes were not subject to statistical analyses. Despite its limitations, the study findings support the notion that treating cognition may lead to linguistic gains and that non-linguistic tasks may be of benefit in aphasia. Some tasks within ATP (Helm-Estabrooks et al., 2000) such as memorising designs and pictures, and categorising pictures have potential for use in global aphasia, others such as clock drawing and trail making may be too complex for those with the condition.

There is some limited evidence that treating cognition can also lead to improvements in functional communication. In her 2005 paper, Ramsberger summarised the findings of Hardin & Ramsberger (1994) who used a computerised cognitive treatment programme called Psychological Software Society Cognitive Rehabilitation (PSSCogRehab; Bracy, 1994) with a participant with fluent aphasia and found functional communication gains. PSSCogRehab (Bracy, 1994) contains over 60 nonverbal cognitive tasks (across a range of domains) hierarchically ordered in terms of complexity. The participant was provided with 51 hours of treatment over 12 weeks, but it is unclear which of the 60 tasks within PSSCogRehab (Bracy, 1994) were used. The programme appears to include visual and auditory attention tasks with simple instructions such as having to tap a button on the keyboard either when a yellow square appears or when a particular sound is heard. However, tasks within PSSCogRehab (Bracy, 1994) quickly progress to becoming more complex, requiring comprehension of lengthy and abstract instructions which would be unsuitable for PwGA. For example, in a visual reaction task, the participant is required to focus on a spot in the centre of the screen. Frames then randomly appear on the screen (between three and nine in number) and whenever two frames are filled in yellow at the same time the participant must press a button. Hardin & Ramsberger (1994) found little change in language as measured by the PICA (Porch, 1967) after treatment. However their participant improved by 15 percentile points on The Trail Making Test (Reynolds, 2002), a test of executive function. In addition, transactional success in conversation (the ability to convey the main ideas in a supported conversation) increased from 46% to 75%. The mechanism for this improvement in conversation is not discussed and is difficult to infer given the lack of detail on the tasks. However, Ramsberger (2005) concluded that there is an important relationship between attention and functional communication skills and suggests that treating attention/executive functions may improve functional communication. The results of this study are promising but must be treated with caution due to the fact it was a single case study with methodological flaws such as lack of a control measure. In addition, due to the broad range of domains and tasks targeted within the PSSCogRehab (Bracy, 1994) programme, it is difficult to know which elements of the intervention were responsible for the improvements reported.

In summary, there are five domains of cognition but no clear understanding of how these domains interact or whether a hierarchy exists. The literature in aphasia has particularly focused on the domains of attention and executive functioning. There have been attempts to ascertain whether cognitive rehabilitation targeting these domains can lead to improvements in language or communication. There are three main approaches to cognitive rehabilitation: individualised cognitive rehabilitation, cognitive stimulation and practice orientated cognitive training. Interventions using individualised cognitive rehabilitation or practice orientated cognitive training approaches have been investigated in TBI and aphasia and there is some evidence to suggest these can lead to improvement in linguistic areas such as reading and auditory comprehension. However, few cognitive interventions that have been described are suitable for use in global aphasia and evidence for generalisation to functional communication is limited. There is a need to explore cognitive interventions for people with severe linguistic deficits and to investigate the impact of such interventions on functional communication.

2.6 Chapter summary

In global aphasia cognition is commonly affected alongside language. Few language or cognitive assessments have been developed with global aphasia in mind. Therefore, existing tools are rarely able to highlight these individuals' residual skills. There are a limited number of intervention studies for global aphasia. Many have serious methodological limitations and constitute Level 4 evidence (CEBM, 2009). Where intervention studies have reported gains for PwGA, dose and a focus on cognition appear to be key factors. Either the intensity or duration of intervention has been high, or cognition has been treated directly alongside language, or unwittingly due to the nature of the intervention tasks. There is an indication from the literature on both severe and global aphasia that having less impaired cognition increases the likelihood of benefitting from an intervention, particularly at a functional communication level. Evidence suggests treating cognition may be advantageous and have the potential to influence both language and functional communication. However with the exception of VAT (Helm-Estabrooks et al., 1982) cognitive interventions suitable for global aphasia have not been developed.

In conclusion, there is a need for an intervention that 1) targets cognitive skills, 2) has little or no linguistic demand so as to be accessible to PwGA, and 3) has the potential to improve functional communication. The novel intervention designed and tested in this thesis aims to fulfil these needs. This review also suggests there is a need for a functional communication assessment that is appropriate for global aphasia, and which is able to directly measure change without relying on a proxy. The Interaction Profiling

Tool (INTERPReT; Adjei-Nicol, Sacchett, & Beeke, n.d.) is such an assessment designed for the purpose of this study. Before describing their development, a survey of current SLT practice for rehabilitation of communication and cognitive skills in global aphasia is reported in Chapter 3.

3 Survey of current SLT practice in global aphasia

The literature presented thus far provides evidence to support the development of a novel cognitive intervention for use in global aphasia. To develop such an intervention for clinical use within the UK, it is important to understand what constitutes current SLT intervention for global aphasia in terms of service provision, assessment and treatment practices. It is useful also to consider the challenges and barriers that exist for SaLTs working with this client group and their views on research priorities. To date, no survey has investigated these issues and this survey was therefore designed specifically to gain such understanding. Section 3.1 will describe the development of the survey and Section 3.2 the methodology for evaluation. Survey results are presented in section 3.3 and the findings are discussed in Section 3.4. The chapter ends with a conclusion in Section 3.5.

3.1 Survey development

A survey was developed with questions related to eight themes closely mirroring the content of published surveys of aphasia service provision such as Katz et al. (2000). These were 1) demographics of respondents 2) definitions of global aphasia 3) services offered 4) assessment 5) intervention practices 6) discharge practices 7) challenges of global aphasia, and 8) research priorities in global aphasia. To ensure accurate interpretation of findings, it was important to understand how SaLTs define global aphasia. The term is not in common use and severe aphasia is an umbrella term that sometimes includes global aphasia. Questions were therefore included to ascertain whether clinicians make a distinction between severe and global aphasia and if so how.

The survey contained a mixture of closed multiple choice and free text questions with free text boxes to elicit information such as the types of goals set with PwGA, the challenges that SaLTs experience when working with this client group, and priority research areas. UCL (University College London) Opinio 6.8, a web-based tool for creating, distributing, reporting and analysing surveys was used.

The survey was piloted with a group of five SaLTs who were asked for their feedback on how long the survey took to complete and whether the wording of questions was clear. They were also invited to make general comments. Feedback confirmed that it was possible to complete the survey within 15 minutes. No questions were added or removed as a result of the piloting process. However, the response options for a question on time post onset were adjusted after feedback that the options overlapped, and demographic questions were moved to the start of the survey. The final survey contained 32 questions of which 23 were closed multiple choice and 9 free text responses (see Appendix 1).

The questionnaire was designed with skip logic to filter out irrelevant questions based on a participant's previous response. Therefore, not all participants answered all 32 questions.

3.2 Survey methods

3.2.1 Recruitment

Qualified UK SaLTs working with adults with acquired communication difficulties were recruited to participate in the survey. An email request was sent to members of national SLT Clinical Excellence Networks in Adult Neurology, Aphasia Therapy and Brain Injury as well as to members of the British Aphasiology Society, UCL Aphasia Research Group and the researcher's network of current and former colleagues. It is estimated that approximately 150 SaLTs received the survey request. The survey was available for one month between 20th September and 18th October 2013.

3.2.2 Ethical issues and consent

UCL Research Ethics Committee confirmed this survey was a service evaluation and therefore ethical approval was not required. The first page of the survey (Appendix 1) explained that it was being completed as part of a research study and that results would be anonymous.

3.2.3 Data analysis procedures

Three types of frequency data for each multiple-choice question were used for analysis as generated by Opinio 6.8. These were absolute frequency, percentage relative frequency (the percentage of respondents giving a response out of the total number of respondents for the entire survey), and percentage adjusted relative frequency (percentage of respondents giving a response out of the total number of respondents for that question only).

The textual data generated by open questions were analysed thematically drawing on the method described by Braun & Clarke (2006). For all except two open questions (19 and 29), inductive thematic analysis was used whereby each respondent's data was coded without the constraint of any pre-existing coding frame or focus on the semantic content of responses. Instead responses were coded by identifying underlying ideas and assumptions consistent with what Braun & Clarke (2006) describe as latent themes. The codes generated in this way were analysed and those that revealed similar ideas or underlying theoretical assumptions were grouped into themes. Next, these themes were further reviewed and refined to check the fit of data with the assigned theme. Finally, these themes were assigned names and analysed. As part of the analysis the numbers and proportion of respondents whose responses fitted a specific theme were calculated and reported on. This aspect whilst helpful for this study is not part of the method described by Braun & Clarke (2006). For questions 19 and 29, which focused on intervention goals and intervention tasks, a pre-existing coding frame was assigned in order to characterise the example goals/tasks provided as functional, impairment-based or both.

3.3 Results

Results are summarised according to the eight topics addressed in the survey:

1) demographics of respondents (see Section 3.3.1)

2) definitions of global aphasia (see Section 3.3.2)

3) services offered (see Section 3.3.3)

4) assessment (see Section 3.3.4)

5) intervention practices (see Section 3.3.5)

6) discharge practices (see Section 3.3.6)

7) challenges (see Section 3.3.7)

8) research priorities (see Section 3.3.8)

3.3.1 Demographics of respondents

In total 52 SaLTs responded to the survey. However, only 29 completed the survey in its entirety. Sixteen respondents completed the closed questions only and an additional seven completed the demographic questions only. Consistent with the approach used by Rose, Ferguson, Power, Togher, & Worrall (2014), results from these seven were excluded. Analysis of closed questions was therefore based on the results from 45 respondents, with analysis of textual responses based on a subset of 29 respondents. With no available data on numbers of UK SaLTs providing services for global aphasia, it is not possible to calculate percentage response rate. All regions of England were represented but the majority were from South East England (33/45, 73.3%). There were no responses from Northern Ireland and only one from Scotland and one from Wales. The respondents represented a cross section of the profession in terms of years' experience.[1] Although respondents were given the opportunity to select more

[1] In the UK National Health Service (NHS), roles are allocated a banding according to the level of specialist skill and experience required to fulfil them. SaLTs are usually banded between 5-8, with Band 5 referring to a newly qualified SaLT, Band 6 a specialist SaLT, Band 7 a Highly

than one clinical setting, none did so. Five respondents did not work within the NHS. Of those that did, the highest proportion worked within acute services. Table 1 details the geographical region, NHS banding, number of years' experience and clinical setting of respondents.

Table 1 Demographics of survey respondents

Characteristic	Number of respondents (n=45)
Geographical region	
South East England	33 (73.3%)
North East England	3 (6.7%)
Midlands	2 (4.4%)
South West	2 (4.4%)
East of England	2 (4.4%)
North West England	1 (2.2%)
Wales	1 (2.2%)
Scotland	1 (2.2%)
Years of clinical experience	
0-2	8 (17.8%)
3-5	11 (24.4%)
6-10	14 (31.1%)
Over 11	12 (26.7%)
NHS banding	
Band 5	6 (13.3%)
Band 6	13 (28.9%)
Band 7	18 (40%)
Band 8	3 (6.7%)
Other	5 (11.1%)
Clinical setting	
Acute	16 (35.5%)
In-patient rehabilitation	11 (24.4%)
Out-patient	8 (17.8%)
Community	8 (17.8%)
Research	2 (4.4%)

Specialist and Band 8 a Consultant, Manger or Clinical Lead SaLT. Of the respondents working within the NHS, the highest proportion were Band 7.

3.3.2 Definitions of global aphasia

In question 6 respondents were asked in an open format to define global aphasia. Only 29/45 (64.4%) provided a response. When analysed 21/29 (72.4%) of the definitions mentioned severity and impairments across more than one modality, consistent with the definition by Collins (1986). However, 6/29 respondents (20.7%) referred only to multiple modalities and not severity, and one referred only to severity and not multiple modalities. Finally, one respondent referred to poor functional communication skills. When asked in the following question whether there was a difference between global and severe aphasia 42/45 (93.3%) stated there was. These respondents were then asked to explain the difference. Only 27/42 respondents (64.3%) did so. When analysed thematically, some responses described more than one difference. Seventy-eight percent (21/27) of responses mentioned the distinction as pertaining to whether all modalities of communication were affected or not, with global aphasia affecting all modalities and severe aphasia just one modality. Eight of 27 responses (29.6%) described the distinction as relating to whether the person's communication was functional, with PwGA considered to have little or no functional communication, whereas those with severe aphasia were described as having some residual ability to communicate effectively by non-verbal means. Finally, two responses (7.4%) mentioned the severity of impairments, with PwGA being more severely impaired than those with severe aphasia.

3.3.3 Services for global aphasia

Respondents were asked to select one option from a multiple choice list of how many PwGA they see in one year. Results were further broken down into the clinical setting where respondents worked, and findings are detailed in Table 2.

Table 2 Approximate number of PwGA seen by respondents and type of clinical setting

Number of PwGA seen per year	**0-5**	**6-15**	**16-30**	**31-50**	**>50**
Number of respondents (n=45)	13	15	13	3	1
	Breakdown by clinical setting				
Acute	0	3	9	3	1
Inpatient Rehabilitation	8	3	0	0	0
Outpatient	3	4	1	0	0
Community	0	5	3	0	0
Research	2	0	0	0	0

Next, respondents were asked how long post onset PwGA on their caseload are. Multiple choice options were provided, and respondents were able to select all applicable responses. Seventy-seven responses were provided in total by the 45 respondents as shown in Table 3. Of note is that 20% (9/45) of respondents see PwGA up to 5 years post onset and 5/45 (11.1%) more than 5 years post onset. These 14 respondents worked in out-patient, community and research settings.

Table 3 Time post onset that PwGA are seen for SLT

Time post onset of PwGA	**Number of respondents n=45**
0-4 weeks	22 (48.9%)
5-12 weeks	19 (42.2%)
4-6 months	13 (28.9%)
7-12 months	9 (20%)
1-5 years	9 (20%)
Over 5 years	5 (11.1%)

To understand the intensity of intervention offered for global aphasia, respondents were asked how often they provide input. This was a multiple-choice question and results are shown in Table 4 alongside clinical settings of respondents. PwGA are most likely to be seen between one and three times a week with 13/45 (28.9%) of respondents reporting once weekly sessions and 14/45 (31.1%) seeing these clients two to three times a week.

Table 4 Frequency of intervention for PwGA and clinical setting of respondents

Number of times PwGA are seen	Number of respondents n=45	Clinical setting of respondents
2-3 times a month	6 (13.3%)	Community n=4 Out-patient n=2
Once a week	13 (28.9%)	Acute n=8 Out-patient n=5
2-3 times a week	14 (31.1%)	acute n=4 in-patient rehab n=6 community n=4
4-5 times a week	9 (20%)	acute n=4 inpatient rehab n=5
Other	3 (6.7%)	Research n=2 Out-patient n=1

Those who worked in community or out-patient settings were asked to indicate whether service provision was time limited (only allowed for a set duration of time) and results indicated that for the majority (13/16, 81.3%) this was not the case. For those where this was the case, SLT provision was limited to 4-6 weeks or 7-12 weeks.

3.3.4 Assessment

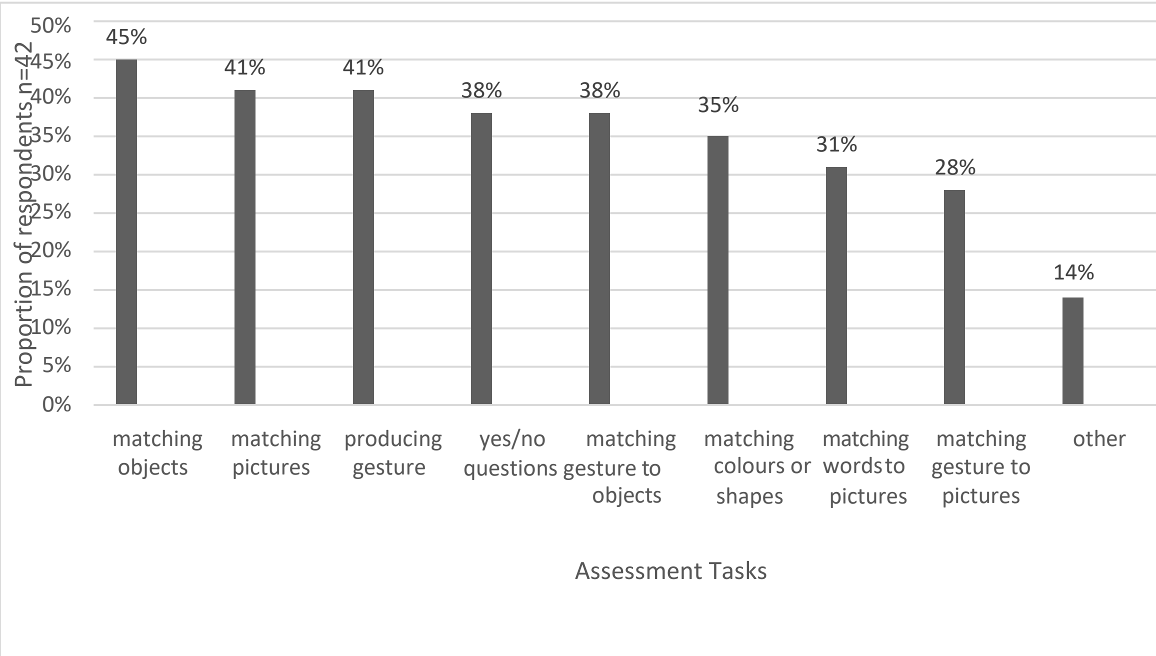
Table 5 presents data from the multiple-choice question on assessment types. Respondents were asked the type of assessments used with PwGA and could select all that apply. Informal approaches were found to be the most common method of assessing global aphasia. Informal language and functional communication assessments were each used by 42/45 (93.3%) of respondents. In contrast, just over half reported using standardised language assessment (23/45 or 51.1%). Thirteen of 45 respondents gave a response of “other” but only three gave specific examples of the assessment(s) they used. These were general client observation and indirect assessment through conversation and family questionnaires.

Table 5 Type of assessment used with PwGA

Assessment type	Number of respondents n=45
Informal non-standardised language assessment	42 (93.3%)
Informal functional assessment	42 (93.3%)
Standardised language assessment	23 (51.1%)
Other	13 (28.9%)
Standardised functional assessment	5 (11.15%)

The 42 respondents who used informal non-standardised language assessments were asked to select the tasks they used from a multiple choice list (Figure 1). Matching objects were the most commonly reported but a range of informal assessment tasks were being used.

Figure 1 Tasks used within informal language assessments with PwGA



Those who used standardised language assessments were asked if they ever used the resulting scores to formally classify a client as having global aphasia, and the majority (18/23, 78.3%) did not. However, this could be due to the particular assessment used not providing the opportunity to classify aphasia type.

Thirty five of 45 (77.8%) respondents reported assessing cognition. They were subsequently asked to select all the cognitive parameters assessed from a multiple choice list (see Table 6). Attention/concentration and memory were the two most frequently reported parameters, with 25/35 (71.4%) and 23/35 of respondents (65.7%)

assessing these areas respectively. Concentration refers to the ability to sustain attention on a task and although the term is rarely used in published texts on cognition, in clinical settings it is often used interchangeably with attention. As the survey targeted SaLTs in clinical practice, the terms attention and concentration were grouped together as one cognitive domain. The five respondents who selected “other” all reported that they assessed “problem solving”.

Table 6 Cognitive parameters assessed by respondents

Cognitive parameter	**Number of respondents n=35**
Attention/concentration	25 (71.4%)
Memory	23 (65.7%)
Visual processing	19 (54.3%)
Self-monitoring /self-regulation	18 (51.4%)
Planning	16 (45.7%)
Organising	13 (37.1%)
Other	5 (14.3%)

Question 13 asked those respondents who reported assessing cognition (n=35) to indicate using a multiple-choice list what kind of assessment they used. Thirty three of 35 (94.3%) use informal cognitive assessment, 11/35 (31.4%) a formal cognitive screen, and 11/35 (31.4%) a standardised cognitive assessment. The four respondents who selected “other” (11.4%) did not provide any free text data. Those who reported using either a formal cognitive screen or standardised cognitive assessment indicated the use of an ‘object decision test’ (source unknown), RCPM (Raven, 1956), Birmingham Object Recognition Battery (Riddoch & Humphreys, 2008), Visual Patterns Test (Della Sala, Gray, Baddeley & Wilson, 1997), and Wechsler Abbreviated Scale of Intelligence (Wechsler, 1997).

3.3.5 Intervention practices

Thirty-nine of 45 respondents (86.7%) reported providing direct intervention to PwGA. Twenty three of 45 (51.1%) reported that their service for global aphasia consisted of one to one intervention only, 2/45 (4.4%) group treatment only and 14/45 (31.1%) both 1:1 and group intervention. Six respondents reported they only provided other types of intervention such as research sessions, conversation partner training and education sessions. The 37 respondents who provided direct one to one intervention (either alone or combined with group treatment) were asked to select from a multiple choice list all the reasons behind such a clinical decision (see Table 7). Only 17/37 (45.9%) of respondents stated that their service automatically offered one to one therapy to all PwGA. For others, a clinical decision was made based on factors such as whether a client demonstrated the pre-requisites skills to participate in and respond to treatment (16/37, 43.2%) or whether the client had benefited from previous intervention(14/37, 37.8%). Five of 37 (13.5%) considered the client's social situation/setting and in individual cases the decision was based on service capacity or how much treatment the PwGA had previously received.

Table 7 Factors considered when deciding to offer 1:1 intervention to PwGA

Reasons for decision regarding 1:1 intervention	Number of respondents n=37
All CwGA are offered 1:1 treatment	17 (45.9%)
It depends on whether the CwGA has the necessary pre-requisite skills to participate in and respond to treatment	16 (43.2%)
It depends on the CwGA' s response to treatment they have already had	14 (37.8%)
It depends on the setting/social situation the CwGA is in	5 (13.5%)
It depends how much treatment the CwGA has already had	1 (2.7%)
It depends on whether my service has sufficient capacity to see CwGA. They are not always a priority.	1 (2.7%)

CwGA= client with global aphasia

All 45 respondents provided an answer when asked to detail in open text the average session duration for PwGA. For 20/45 (44.4%) of respondents, the average session duration was 45-60 minutes, for 13/45 (28.9%) of respondents it was 30-40 minutes, and for 10 (22.2%) respondents, a session lasted for 20-30 minutes on average. All 10 respondents whose sessions lasted 20-30 minutes on average worked in an acute setting. The other reported session timeframes occurred across a mixture of settings.

Respondents were asked to select from a list of therapy approaches all those used with this client group. Table 8 highlights that a total communication approach was used by the majority of respondents (43/45, 95.5%). PACE (Davis & Wilcox, 1985) was used by 23/45 (51.1%) of respondents and computerised therapy programmes specified as SWORD©, StepByStep©, REACT©, Proloquo2go©, Tactus naming therapy apps and non-specified iPad apps by 13/45 (28.9%). Non-verbal approaches, AMER-IND (Skelly & Schinsky, 1979) and VAT (Helm-Estabrooks et al., 1982) were used by one respondent each.

Table 8 Therapy approaches used for direct intervention with PwGA

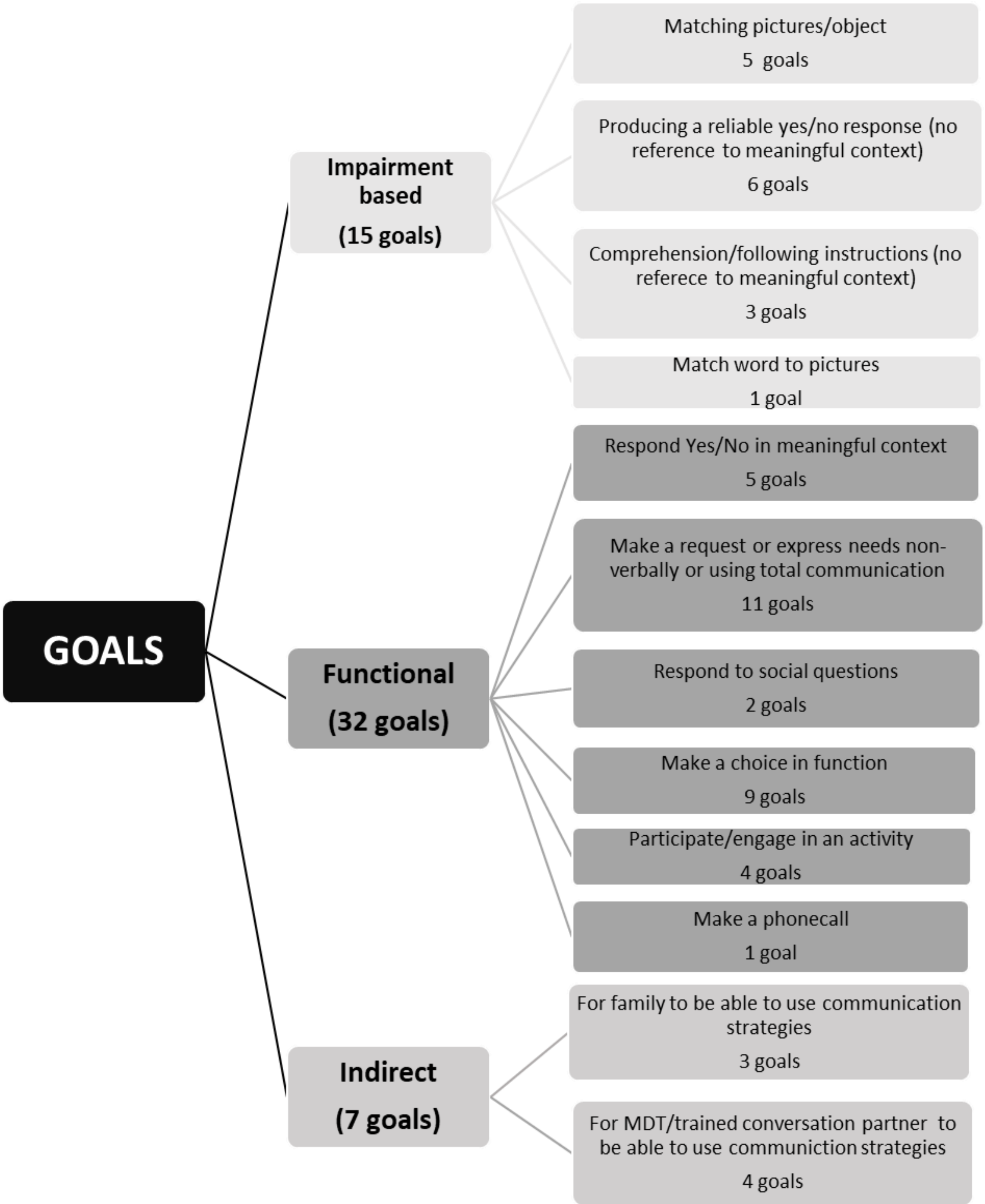
Therapy approach	**Number of respondents** **n=45**
Total communication	43 (95.5%)
PACE (Davis & Wilcox, 1985)	23 (51.1%)
Group treatment	18 (40%)
Computerised therapy programmes	13 (29%)
Other	6 (13.3%)
VAT (Helm-Estabrooks et al., 1982)	1 (2.2%)
Amer-Ind (Skelly, 1979)	1 (2.2%)

The following question asked respondents to select the types of indirect treatment provided. All 45 respondents reported providing education to family members about how best to communicate with the client, 40/45 (88.9%) provided education to the multi-disciplinary team (MDT) and 34/45 (75.5%) modified the environment of the PwGA.

When asked in an open question for two examples of goals set for PwGA, only 29 respondents answered. Fifty-four example goals were provided in total with four respondents providing one goal rather than two. Goals were assigned to pre-determined categories: impairment-based, functional, indirect (see Figure 2). In total, 27.8% (15/54) of goals were impairment based, 59.3% (32/54) functional and 13% (7/54) indirect in nature. The most common goal was a functional one, related to PwGA being able to express their basic needs. This example was provided on 11 occasions, representing 20.4% of the goals given by respondents. There were also 11 goals related to clients being able to give a yes/no response. Some yes/no goals (5/11), were functional in nature and related to a question about wants, needs or feelings and 6/11 were impairment-based referring to yes/no being "consistent" or "reliable" rather than used in a meaningful context. The next most commonly reported goal (provided nine times, representing 16.7% of goals given), related to the client being able to make a choice in a functional context. Some respondents specified the functional context as washing, dressing or during meal-times.

Goals were classified as indirect if the focus of the goal was on a communication partner rather than the client with global aphasia. Four of the seven indirect goals related to a member of the MDT or a trained conversation partner being able to use appropriate strategies to communicate with the client, while the remaining three related to the strategy use of relatives or friends.

Figure 2 Examples of intervention goals set for PwGA



A list of 16 therapy tasks was then provided and respondents were asked to select all those they had used with PwGA. Table 9 lists the responses in order of frequency of reported use. Consistent with the fact that total communication was the most commonly used treatment approach, tasks that targeted alternative modes of communication were the most commonly reported. Drawing was used by 38/45 respondents (84.4%) and gesture production tasks by 36/45 respondents (80%). Games were less commonly used, 18 respondents (40%) used playing cards, whilst 17 (37.8%) used Connect4© and 13 (28.9%) jigsaw puzzles and dominoes. Only 7/45 (15.5%) reported using "other" tasks and examples provided were automatic speech and phrase completion.

Table 9 Therapy tasks used with PwGA

Therapy task	**Number of respondents n=45**
drawing	38 (84.4%)
producing gesture	36 (80%)
matching objects	35 (77.8%)
matching words to pictures	35 (77.8%)
yes/no response practice	35 (77.8%)
making choices between objects by pointing	35 (77.8%)
matching pictures	34 (75.5%)
matching gestures to objects	32 (71.1%)
writing	30 (66.7%)
matching gestures to pictures	30 (66.7%)
sorting objects by category	28 (62.2%)
playing cards	18 (40%)
playing Connect 4	17 (37.8%)
completing jigsaw puzzles	13 (28.9%)
playing dominoes	13 (28.9%)
other - please specify	7 (15.5%)

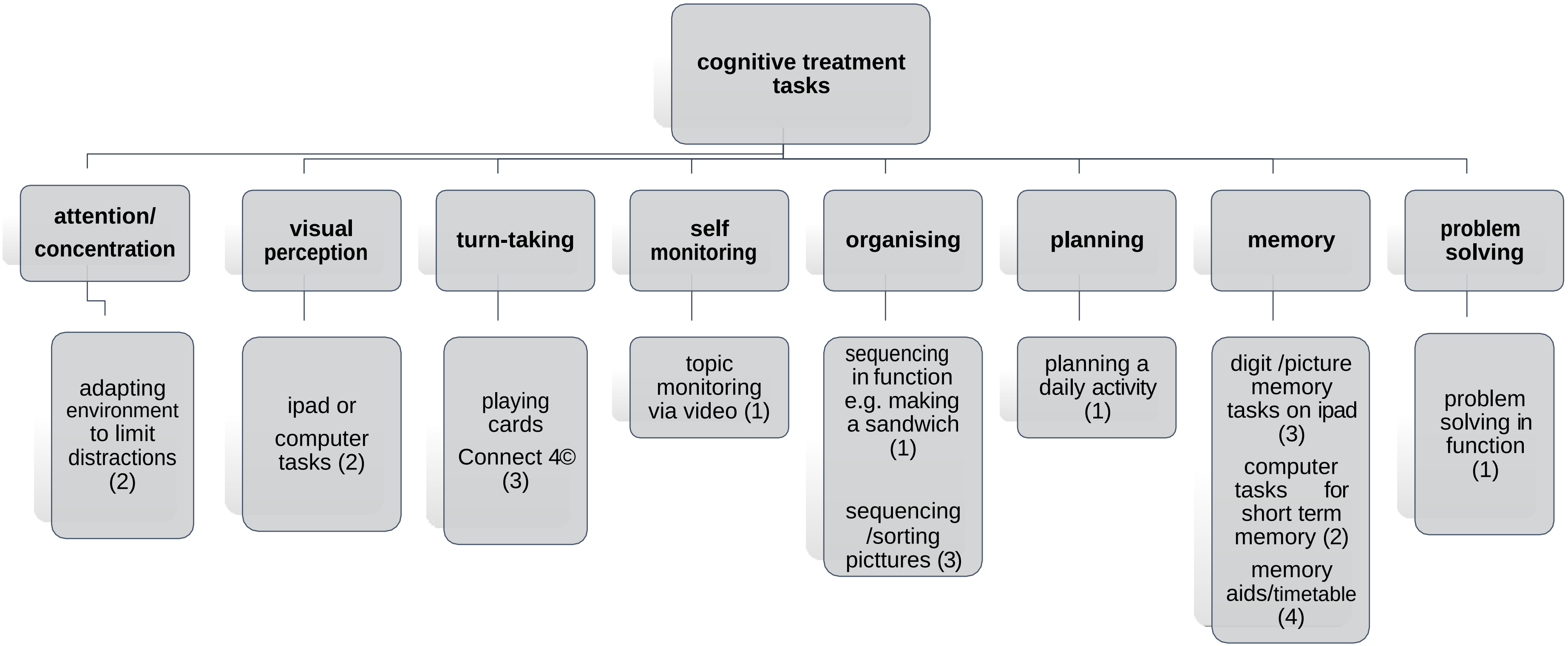
Two thirds of respondents (30/45, 66.7%) reported offering cognitive treatment and they were asked to select from a list the areas of cognition targeted in treatment. The results are shown in Table 10.

Table 10 Cognitive parameters treated by SaLTs working with PwGA

Cognitive parameter treated	**Number of respondents n=30**
attention/concentration	27 (90%)
memory	24 (80%)
organising	18 (60%)
visual processing	18 (60%)
planning	15 (50%)
self-monitoring /self-regulation	15 (50%)

Respondents who treated cognition were asked in an open question to give examples of cognitive therapy tasks they use. Twenty-three examples were provided by fifteen (50%) of the 30 respondents. These examples were analysed and grouped into eight cognitive areas (see Figure 3).

Figure 3 Cognitive treatment tasks used with PwGA



When asked if they worked jointly with members of the multi-disciplinary team (MDT) when treating PwGA, 38/45 (84.4%) of respondents stated that they did so. These 38 respondents were asked which professionals they worked with (see Table 11). Occupational Therapy (OT) was the most frequently reported profession with 32/38 (84.2%) respondents working with them. Two respondents stated they would like to work with OT colleagues but lacked staffing resources to be able to do this.

Table 11 Professions SaLTs work with when treating cognition in global aphasia

Profession	Number of respondents n=38
Occupational Therapy	32 (84.2%)
Physiotherapy	23 (60.5%)
Psychology	17 (44.7%)
Nurse	6 (15.8 %)
Doctor	6 (15.8 %)
Support worker/ volunteer	6 (15.8 %)
Social worker	3 (7.9%)
Dietitian	3 (7.9%)
Chaplain	1 (2.6%)
Advocate	1 (2.6%)
Counsellor	1 (2.6%)

Respondents were then asked to give examples of tasks carried out jointly with members of the MDT and 37/38 respondents (97.4%) gave examples (see Table 12). Tasks involving recognition or use of objects in functional activities were most common.

Table 12 Cognitive treatment tasks carried out with members of the MDT

Cognitive treatment task	Number of respondents n=37
Object recognition/use in functional activity e.g. washing, dressing, mealtime	19 (51.4%)
Mood assessments / therapy sessions regarding mood	6 (16.2%)
Supporting client to follow instructions in MDT treatment sessions	5 (13.5%)
Physiotherapy sessions on positioning	5 (13.5%)
Sequencing / planning tasks	3 (8.1%)
Capacity assessments	3 (8.1%)
Educating/supporting MDT member to communicate with client	3 (8.1%)
Community access/home visits	3 (8.1%)
Supporting client to make decisions/choices in care/leisure activity	2 (5.4%)

3.3.6 Discharge practices

All respondents were asked to select from a list of six options the factors they considered when deciding whether to discontinue treating PwGA. Respondents were able to select all that applied and also had the option to select “other”. Table 13 details the responses provided and highlights that factors are similar to those that would be considered with other types of aphasia, such as whether the client had achieved their therapy goals (39/45, 86.7%), the SaLT having a sense that the client had plateaued (39/45, 86.7%), and the motivation of the client (39/45, 86.7%). Of the three (6.7%) respondents who selected “other”, one specified that they considered how the client and carers were coping with residual difficulties and two reported that they considered whether their service was able to offer further sessions.

Table 13 Factors considered when discharging PwGA

Discharge factor considered	**Number of respondents n=45**
Achievement of SLT goals	39 (86.7%)
A sense that the client has plateaued	39 (86.7%)
Client motivation	39 (86.7%)
Self or carer report of changes	23 (51.1%)
Amount of treatment already offered	9 (20%)
Changes in language assessment scores	6 (13.3%)
Other-please specify	3 (6.7%)

3.3.7 Challenges of working with PwGA

When asked to complete the sentence “One key challenge in treating clients with global aphasia in my clinical experience is”, 29/45 respondents (64.4%) provided a response. Three responses were found to contain two challenges so in total 32 examples were provided. These were analysed thematically. Seven themes were generated from the responses and are listed in Table 14. The most commonly reported challenge was dealing with clients who lack insight and motivation (9/32, 28.1%). The next most commonly reported challenge was the expectations of the family (7/32, 21.9%) and the challenge of treating cognitive deficits (4/32, 12.5%). The term “unrealistic” was frequently used when referring to the expectations of family. Less commonly reported themes were the severity of impairments of PwGA, lack of resources, and time pressures in the acute environment. The responses grouped as “other” referred to lack of opportunity to work jointly with other professionals and lack of confidence.

Table 14 Challenges of working with PwGA (grouped by theme)

Challenges working with PwGA	**Number of responses reflecting this theme n=32**
Lack of insight and motivation of clients	9 (28.1%)
Expectations of family	7 (21.9%)
Treating cognitive deficits	4 (12.5%)
Severity of impairments	3 (9.4%)
Lack of therapy resources/ideas	3 (9.4%)
Time pressures in acute setting	3 (9.4%)
Other	3 (9.4%)

3.3.8 Research priorities

Finally, respondents were asked to complete the sentence "One area or question I feel needs more research with respect to the treatment of clients with global aphasia is". Twenty nine people (64.4%) responded. These responses were analysed thematically into five themes (see Table 15). Research into evidence based treatments, determining if PwGA can benefit from SLT and underlying impairments that frequently co-occur with global aphasia (including cognition, motivation and engagement) were most commonly reported. Less common suggestions were research on how to support or train family and friends of PwGA, and the views of clients.

Table 15 Research priorities of respondents (grouped by theme)

Research Priority	**Number of respondents n=29**
Evidence based treatments	10 (34.5%
Potential to benefit from SLT	8 (27.6%)
Underlying cognitive impairments	7 (24.1%)
Training/supporting family/friends	3 (10.3%)
Views of PwGA	1 (3.4%)

3.4 Discussion

3.4.1 Summary of findings

The findings from this survey suggest that despite research and other literature often using the terms severe and global aphasia interchangeably or grouping clients with these conditions together, for clinicians there is a distinction. They describe global aphasia as more severe and affecting more modalities than severe aphasia. Respondents reported frequently assessing cognition alongside language and attempting to treat this domain with support from the MDT. This suggests that cognition is judged to be frequently impaired in global aphasia. These deficits along with severe language impairments and a lack of evidence based treatments, present a challenge for clinicians and are consequently reported to be priorities for future research.

3.4.2 Interpretation of findings concerning service provision

These findings suggest that service provision for global aphasia is consistent with that for other aphasias. Clients are seen 2.5 times a week on average (but this may be more intensive in the acute stages) and they continue to receive intervention until function reaches a plateau or they stop achieving goals. This is an encouraging finding given the negative commentary from authors such as Marshall (1987b, 1987a) that has existed in the past suggesting PwGA should de-prioritised for treatment. However, this finding could also be due to bias inherent within the cohort of respondents. Those who participated in the survey may be more interested in treatment of global aphasia, more confident working with this client group and more likely to provide intervention. Whilst service provision appears consistent with other forms of aphasia, the dose and intensity being provided does not match the limited evidence base that exists. Most studies of global aphasia with positive outcomes, for example Denes et al. (1996) or Samples & Lane (1980) have suggested that a high dosage of treatment is required. However, intensive treatment (4-5 times a week) was not offered by any respondent working in out-patient or community services and offered by less than half of respondents working in acute or in-patient rehabilitation settings. Furthermore, only 20% of respondents see PwGA who are more than 1 year post stroke.

3.4.3 Interpretation of findings concerning assessment and intervention practices

Informal assessment appears to be used more commonly when assessing global aphasia than other aphasia types. Katz et al. (2000) found that 57% of UK based clinicians used informal assessments when assessing PwA. In this survey the figure was far higher at 93%. The discrepancy in findings suggests that SaLTs use informal tests more often with clients who have severe impairments. This provides support for the notion suggested in Section 2.3 that existing standardised assessments are not appropriate for understanding the residual skills of PwGA or for planning their intervention (which are key reasons to assess clinically). Despite definitions and descriptions of global aphasia in the literature rarely describing additional cognitive deficits, nearly 80% of respondents report assessing cognition in this population. Attention/concentration was the most commonly assessed domain, consistent with the literature described in section 2.5 that suggests attention deficits are common in aphasia. Similar to language assessment methods, respondents rely heavily on informal assessment of cognition. This suggests existing standardised cognitive assessments may not be appropriate for this population either.

One to one intervention appears to be favoured over group intervention in global aphasia. Only thirty-six per cent of respondents stated they offered group intervention alone or group alongside one to one intervention, which is less than in aphasia treatment more generally. For example, Rose et al. (2014) found that around 50% of respondents offered group treatment for PwA in Australia. The limited use of group treatment is consistent with the literature on global aphasia, where only one or two case studies of group interventions exist (for example, Lawson & Fawcus, 1999). Respondents reported that pre-requisite skills and response to previous treatment were the factors which most influenced whether one to one intervention was offered.

Although they were not asked specifically to detail what these skills were, it is reasonable to infer that if PwGA responded well to previous treatment, for example by engaging or demonstrating gains, they would be offered further individual intervention. If not, they may be offered group intervention or no further therapy. These findings suggest that those with particularly severe forms of aphasia who have difficulty engaging in therapy or are so profoundly impaired that they fail to make gains are deprioritised for one to one intervention. This is consistent with the hypothesis of Van Mourik et al. (1992) who suggested that there is a group of PwGA who are so impaired that direct intervention is not possible and input should be directed towards significant others or supporting social interaction. However, one could argue that it is precisely these profoundly impaired clients who would benefit from a period of individually tailored intervention targeting underlying cognitive and communication skills relevant to participating in SLT. In addition, given findings from Sarno & Levita (1981) and Samples & Lane (1980) that PwGA often require prolonged periods of intervention, it could be argued that severely impaired clients who have previously failed to respond to intervention were not offered a high enough dose.

Findings strongly suggest that provision of indirect interventions for global aphasia does not differ from that provided for other aphasia types. The most common treatment goals were for clients to be able to express their basic needs or make a choice in function. Many of the commonly reported therapy tasks would require clients to have a basic level of cognitive skill. For example, drawing, gesture production, matching objects/pictures or gestures, all require intact visual perception, selective attention and in some cases non-verbal semantics. Therefore, these tasks may be beyond those PwGA who also have severe cognitive deficits. The findings reveal that 66% of respondents are treating cognition and of this group over 80% do so jointly with MDT colleagues, particularly from OT and psychology. The focus of such intervention is frequently functional tasks relevant to activities of daily living (such as recognising or using real objects during washing, dressing, and meal-times). However, no specific cognitive treatment approaches or tools were mentioned, and neither were tasks targeting underlying impairments in a specific cognitive domain being carried out. In addition, some respondents reported OTs in their teams were not able to engage in MDT working because of service pressures. These findings suggest that SaLTs recognise the importance of treating cognition in global aphasia but feel unable to do so without support of MDT colleagues. There may be some PwGA for which current cognitive input (focused on functional daily living tasks) is too complex, and who instead require impairment based intervention targeting specific underlying cognitive skills. Given the nature of impairments in global aphasia, any such intervention would need to have little or no linguistic requirements. Very few respondents are currently using non-verbal intervention approaches, but half reported they would be willing to try such an approach.

3.4.4 Implications for clinical practice and future research

Findings suggest that experienced SaLTs work with PwGA. Respondents represented a broad range of clinical experience, but there were more Band 7 SaLTs who responded than Band 6 and Band 5. This may purely be due to senior clinicians feeling confident to respond and contribute to research, or it could be linked to the challenges working with this client group and suggestive of their complexity. Service managers may need to consider global aphasia as a complex condition requiring experienced SaLTs to take the lead in treating.

Alongside the expectations of relatives, reduced insight, motivation, and cognition were amongst the main challenges reported by respondents. These areas appear to be specific challenges when working in global aphasia as they are not reported as a barrier to intervention in other surveys of aphasia practice. For example, in Rose et al.'s (2014) study, service provision and staffing levels were the key challenges. Again, in contrast with other aphasia surveys, these results indicate the priority area for future research is evidence-based treatments. In Rose et al.'s (2014) survey, culturally appropriate treatments and combining impairment and functional treatments were the priorities. This supports findings from the literature review (see Chapter 2) that the evidence base for interventions in less severe forms of aphasia is more substantive and robust than in global aphasia. There is a clear need for an evidence-based intervention suitable for use in global aphasia that has potential for improving goals targeted in SLT such as making a choice or expressing needs. Such an intervention must be viable for clinical use and subsequently should be delivered within 2.5 sessions a week, the average provision delivered. Most respondents stated that their service did not have a set duration of intervention and that they were able to see clients until goals were met. However, there were a handful of respondents whose services only offered a set period of 4-6 weeks intervention. As such an intervention that can be delivered within this timescale would be clinically viable. There is a suggestion from the survey findings that SaLTs do not feel able to treat cognition independently. This could in part be due to lack of training, skills and experience, given that cognition has not been a large part of SLT training in the UK. However, it could also be in part due to lack of clear remit or process as to who within the MDT should lead on cognitive intervention. Further discussion amongst professional groups may be required as well as changes in training to ensure that members of the MDT have the resources and skills to rehabilitate all clients with cognitive deficits, including those with global aphasia.

3.4.5 Survey limitations

Fifty-two responses were received from approximately 150 disseminated surveys, suggesting 35% of those who received the survey responded to it. While consistent with other surveys (for example, the response rate for Katz et al. (2000) was 39%, Rose et al. (2014) and Code & Heron (2003) 33%), this is low and findings must be treated with caution. As few responses were received from Scotland, Wales or Northern Ireland, the results only provide an understanding of practice in England. Future studies should attempt to gain a picture of practice throughout the UK.

Of the 45 respondents who reached the end of the survey, only 29 answered every question. It is possible that despite the timeframe being stated at the beginning, and it being possible to save the survey and return to it later, clinicians did not have sufficient time to complete it. Alternative explanations are that questions were not relevant to their role or their caseload, questions were too difficult to answer, or the respondents lost interest over the course of completion. The survey was completed online and required internet access, a likely possibility (given the survey was disseminated in 2013), is that NHS IT or network connection issues contributed to some respondents' failure to complete the survey. Sixteen respondents completed all closed multiple choice questions but some or none of the open questions. Whilst the intention was for the Opinio software programme to prompt participants if they left a question blank, it appears that this facility may not have worked consistently. This is an oversight which was not noted in the design and testing phase of the survey. A further five respondents placed nonsense words or punctuation signs in the space for open questions. Future surveys should seek to mitigate against such issues of missing data.

Questions about service provision required the respondent to answer based on their own caseload. While meaningful and easy to reflect on for individual SaLTs, such questions do not provide a complete picture of service provision. Given the main aim of this survey was to understand clinical practice, it was important to survey treating clinicians. However, future studies may wish to obtain detail on service provision by targeting service managers as in the case of the survey by Code & Heron (2003).

3.5 Conclusion

This survey suggests that SaLTs recognise that both language and cognition can be affected in global aphasia. However, existing assessment tools may not be appropriate for use with this client group so informal assessment is favoured. Findings reveal that PwGA are consistently being offered some form of SLT intervention and that direct functional communication intervention approaches are most commonly used to target expression of basic needs and making functional choices. Insight, motivation and cognition are cited as key challenges when working with this client group and a need for evidence based treatments was highlighted. These findings motivated the development of a novel non-linguistic intervention for global aphasia targeting basic attention, perception and non-verbal visual semantic skills. The aim of this intervention is to improve functional communication. Given the lack of direct (versus proxy) functional communication assessments suitable for global aphasia, a novel observational assessment was also designed and piloted. The development of both the intervention and assessment will be described in the following chapter.

4 The development and design of a novel intervention and outcome measure

The literature reviewed in Chapters 1 and 2 and the results of the survey detailed in Chapter 3 provide justification for the development of (i) a novel cognitive intervention and (ii) a direct functional communication assessment for PwGA. This chapter will firstly outline the aims of the intervention and theoretical basis for the content (Section 4.1), then describe the design (Section 4.2). Following this, Section 4.3 will detail the materials used and Section 4.4 the process of delivering the intervention. Finally, Section 4.5 will describe the aims and content of the novel outcome measure used in this study.

4.1 Intervention aims

The overall aim of the intervention developed for this study is to improve functional communication in global aphasia. Functional communication is related to everyday life and can be specific to the situations and activities of individuals. A limitation of many existing functional assessments (as described in Section 2.3) is that they do not measure tasks relevant to the everyday life of people with severe forms of aphasia. For the development of this intervention, it was important to understand what broadly constitutes functional communication for PwGA. The results of the survey were informative and suggested that being able to express ones needs using non-verbal communication and being able to make choices in everyday activities such as washing, dressing and meal-times were important functional tasks. SaLTs in the survey relied on a total communication approach (which includes pointing, drawing, gesture, writing and spoken language) to support PwGA achieving these goals. In the interest of simplicity and enabling those with profound cognitive and linguistic impairments to participate, this intervention focused only on the most basic way of communicating one’s need, that is through pointing (Strid, 2007). Another area chosen as a target for intervention was selective attention. In the researcher’s clinical experience, PwGA are often required to communicate in the presence of background noise and visual distractions and are often provided with non-verbal cues such as gesture alongside spoken words. Therefore, tasks that target the ability to attend only to relevant auditory and visual stimuli as well as to understand gesture were also included. Together the above information was used to generate three intervention aims. The intervention aimed to improve the following skills in global aphasia:

- Understanding of non-verbal cues such as iconic gestures
- Ability to express a want, need or choice through pointing at a picture/object from an array of options

- Ability to perform the above tasks in the presence of visual or auditory distractors.

The aims of the intervention are not only consistent with the survey findings and clinical experience but also underpinned by the work of Garrett & Beukelman (1998). These authors suggest that responding to non-verbal signals and indicating needs through pointing are skills that separate “basic choice communicators” who have profound cognitive-linguistic disorders across modalities, cannot initiate basic communication or respond to conversational input or non-verbal signals, from “controlled situation communicators” who can (see Section 2.2, p.22).

In order to address these aims, the intervention targets multiple cognitive functions including attention, perception, semantics and executive functioning. No current model of cognition encompasses all the cognitive domains targeted in this intervention. Consequently, to understand the underlying skills that may be required to complete this intervention the researcher had to draw on single domain models such as: Sohlberg & Mateer’s (1987) model of attention (see Section 2.5, p.35), a model of visual perception proposed by Warren (1993) shown in Figure 4, a model of object recognition proposed by Ellis & Young (1996) shown in Figure 5, and a four stage hierarchical model of auditory perception proposed by Goll, Crutch, & Warren (2010).

Warren (1993) suggests visual processing skills are dependent on: oculomotor control, visual fields and visual acuity, visual attention, scanning, pattern recognition as well as higher level skills such as visual memory and visual cognition. Visual attention is described as a three-step process involving the eye ceasing to focus on something (disengaging), followed by shifting focus to a new object (moving), and finally an operation where the previous object is compared with the new one for similarities and differences (comparing). Visual attention is proposed to be strongly influenced by general attention abilities. Scanning involves the retina recording details of a scene in a systematic, organised way. Pattern recognition is the ability to identify salient features of an object such as colour, shape, texture, contour and details. Visual memory is the ability to visually process information, store it and recall it later whilst visual cognition is the ability to manipulate visual information, integrate it with other sensory information and use contextual cues to obtain meaning from an image. Warren (1993) explains on p.44 that “each skill level depends on the integration of those before it and cannot function effectively without the assistance of its predecessors” and goes on to suggest that in clinical settings, treatment of a higher level skill would not be effective unless the underlying deficits in visual attention and visual field losses are addressed first.

Ellis & Young (1996) propose object recognition is characterised by the following process. First, there is an initial representation stage where the “primal sketch” or two-dimensional geometry of an image is formed which includes the image’s brightness and intensity. Next, viewer centred representation occurs which involves processing the visible surfaces of the image from the viewer’s position. Following this, there may or may not be object centred representation prior to the object recognition units being accessed. Object centred representation involves the formulation of a three-dimensional representation of the image specifying the shape and surfaces of the object independent of the viewer’s position. Object recognition units refer to the stored descriptions of known objects. This focuses on the structural characteristics of the object. Finally, the semantic system provides information on the object’s meaning such as its use and allows for the object to be recognised.

Figure 4 Hierarchical model of visual perception (Warren, 1993)

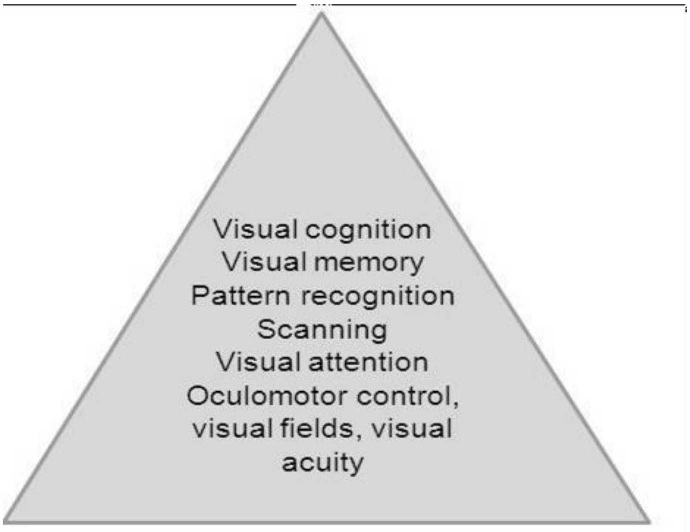
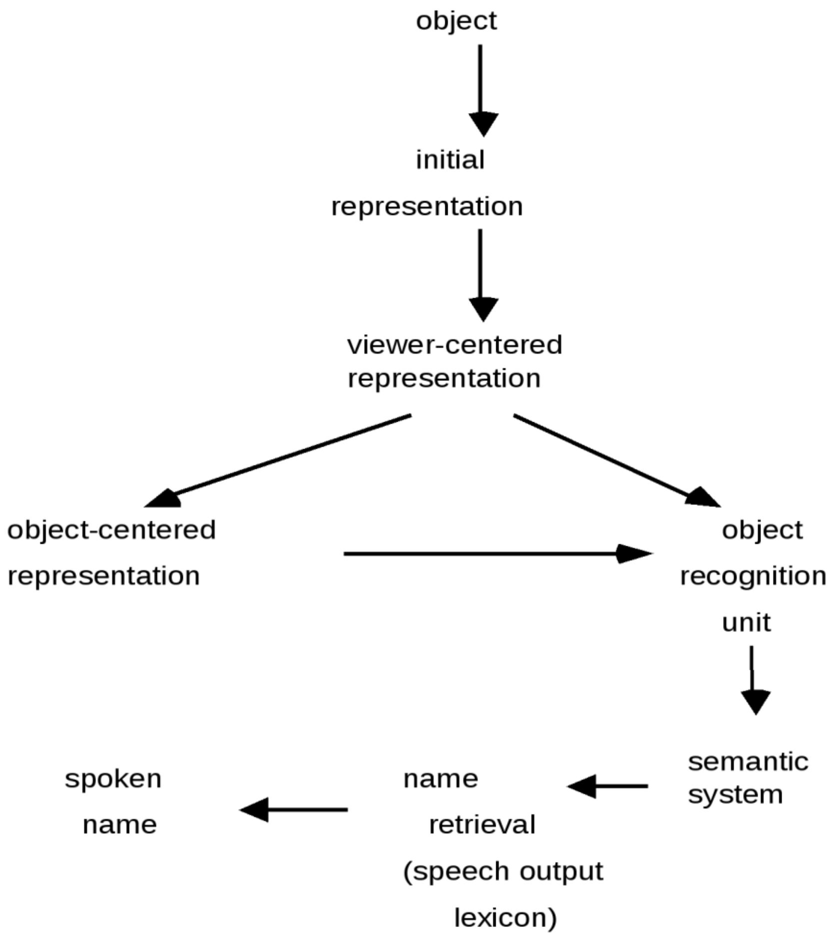


Figure 5 Model of object recognition and naming (Ellis & Young, 1996)



Goll et al. (2010) suggest auditory processing involves; auditory scene analysis (the segregation of acoustic data from background noise), the encoding of auditory properties such as pitch and timbre, followed by the representation of the perceived acoustic as whole and finally recognition of the acoustic data.

With the above information, the cognitive skills required for each aim were identified. To understand non-verbal cues such as iconic gesture (intervention aim 1), one must focus attention on and visually perceive the movement being produced, then connect this with the use of an object (which requires semantic knowledge) and recognise the particular object. According to existing cognitive models, this would involve focused attention (Sohlberg & Mateer, 1987), object recognition (Warren (1993) refers to this as visual memory) and access to the semantic system (Ellis & Young, 1996).

In order to express a need through pointing at an object or picture from an array (intervention aim 2), one must be able to visually scan the array of options, which according to Warren (1993) includes focusing attention on each option in turn, disengaging and shifting attention to other option(s) and making visual comparisons. After this each item must be perceived using pattern recognition, then recognised using visual memory. Finally, object use (meaning) must be comprehended through the semantic system. In a functional communication situation, the need or issue that the PwGA has at that specific moment in time must also be connected with one of the items in the array and the individual must understand that a selection will lead to an outcome (known as cause and effect). This process requires problem solving skills. A further skill required is for irrelevant items within the array to be rejected which according to Sohlberg & Mateer's (1987) model requires visual selective attention skills. Finally, a selection must be made by initiating a pointing response which involves executive function skills (Keil & Kaszniak, 2002; Powell, 2017)

For the third intervention aim, one must be able to communicate a need or make a choice while dealing with people in the background, background noises and the spoken language presented alongside the object, picture or gestural choices. Individuals must therefore be able to attend only to relevant stimuli and ignore irrelevant stimuli. According to the model presented by Goll et al. (2010) this requires auditory attention and perception in the form of auditory scene analysis, auditory encoding and auditory recognition. An additional element of successful real-life communication that is often problematic in global aphasia from the researcher's own clinical experience, is the ability to share joint focus (joint attention) and engage with another person. There is little documented about joint attention in the adult aphasia literature. However, in the developmental literature, joint attention is said to occur when a child and another person attend to the same object or event, and are both aware this attention is shared (Moore & Dunham, 1995). The capacity for joint attention has been proposed to be an important precursor to language and social cognition and it is understood that joint attention provides a reference for learning language and social interaction. Strid (2007) explains that the earliest sign of the emergence of joint attention is when infants start to follow another person's eye gaze or point to objects in their surroundings. A later joint attention behaviour is when infants direct the attention of others' to objects they find interesting. This is also sometimes referred to as communicative intent. Joint attention and communicative intent were not directly targeted in this intervention but considered to be trained indirectly throughout the intervention. This is because each task required the participant to engage with the researcher by first observing the researcher's demonstration of the task requirements, then taking their own turn when prompted, and later responding to the researcher's feedback. The majority of tasks required a pointing response so pointing was also indirectly trained within the intervention.

Table 16 provides a summary of each intervention aim, detailing the sub-components and the underlying skills on which they rely.

Table 16 Sub-components and cognitive skills within each intervention aim

Intervention Aim 1: To understand non-verbal cues such as iconic gestures	
Sub-components of intervention aim	**Cognitive skills required**
Gestural perception	Visual attention (focusing)
Connect gesture with an object by understanding object use	object recognition / visual memory visual semantics
Intervention Aim 2: Express a need/make a choice by pointing at picture /object from an array	
Component part	**Cognitive skills required**
Look between two or more options	Visual scanning Visual attention: focusing, disengaging and shifting gaze, comparing
Recognise objects and pictures	Visual perception: pattern recognition Object recognition/ visual memory
Understand the meaning and use of objects/pictures	Visual semantics
Link a problem with a desired outcome or link a want/need to a specific object	Problem solving Cause and effect
Reject an incorrect /unwanted item	Visual selective attention
Make a selection by pointing	Communicative intent Initiation Limb movement
Understand that a selection will result in an outcome	Cause and effect
Intervention Goal 3: Functionally communicate with visual and auditory distractors	
Component part	**Underlying cognitive skill**
Perceive environmental sounds	Auditory focused attention
Recognise environmental sounds	Auditory semantics
Ignore background noise	Auditory focused attention Auditory selective attention
Ignore visual distractors	Visual selective attention
Maintain a consistent response during an activity	Sustained attention

4.2 Intervention design

The next step in developing the intervention was to design tasks capable of addressing all the skills listed in Table 16. Further considerations when designing the tasks was for them to be non-linguistic and achievable with little to no verbal language requirements as well as for the entire intervention to be completed within 18 sessions (three times a week for no longer than six weeks). Existing cognitive treatments were carefully reviewed. Many tools contained one or two tasks that were suitable, but no existing tool was deemed appropriate in its entirety. For example, APT (Sohlberg & Mateer, 1987) has appropriate non-verbal auditory and visual attention tasks but does not include any tasks for visual perception or object recognition. The selective attention task used by Sturm et al. (1997) (see Section 2.5.2, p.45) could be adapted for PwGA but other attention tasks used would be difficult for PwGA to understand. VAT (Helm-Estabrooks et al., 1982) has suitable non-verbal tasks targeting visual perception and object recognition but has no auditory tasks. In addition, it assumes basic visual attention skills such as scanning and focused attention are intact. PSSCogRehab (Bracy, 1994) used by Ramsberger (2005) includes a variety of visual and auditory attention tasks some of which are appropriate, but no semantic tasks.

Due to the limitations of many existing tools, a combined approach was utilised to design the final content of the intervention programme. Firstly, appropriate tasks within the above cognitive intervention tools were considered for direct replication or adaptation. Then, clinical assessment and intervention tools used within aphasia were reviewed for appropriacy such as Semantic Links (Bigland & Speake, 1992), MCST-A (Garrett & Lasker, 2005) and non-verbal semantic tasks described by Whitworth, Webster, & Howard (2005). Tools used with other populations who have similar impairments to PwGA were also considered. For example, people with autism spectrum disorders can have difficulties with visual perceptual and object recognition skills (Shane & Weiss-Kapp, 2008). An approach developed by Shane & Weiss-Kapp (2008) to aid the development of these skills involves a series of hierarchically ordered tasks from identical and non-identical object matching to object categorisation. This hierarchy was incorporated into the current intervention.

Another relevant population considered was children with cerebral palsy who often rely on eye gaze or eye pointing to make selections and to communicate. Recently, a team of researchers at UCL have developed a set of procedures for analysing eye gaze behaviours such as tracking and shifting gaze and have made these available online (University College London, n.d.). These procedures were adapted into intervention tasks.

People with disorders of consciousness may demonstrate inconsistent but reproducible responses to speech, sound or visual stimuli such as objects (Royal College of Physicians, 2013). Assessments commonly used with this population such as Coma Recovery Scale-Revised (Giacino & Kalmar, 2004) and Wessex Head Injury Matrix (Shiel, Wilson, McLellan, Watson, & Horn, 2000) contain hierarchically ordered tasks requiring a behavioural response to different stimuli. Relevant items from these two tools were also included. Where no suitable existing task could be found to treat a specific skill targeted within this novel intervention, one was designed by the researcher for the purpose of this study. Through this process 16 intervention tasks were set. The aims and content of each task are outlined in Table 17. Some were computer based to allow presentation of timed distractors and use of webcam to review eye gaze, and others were paper based. Where objects or pictures were used, they were presented horizontally unless hemianopia or neglect was a known issue, in which case they were presented vertically. An experimental officer aided development of the computer based tasks.

An attempt was made to order the 16 tasks hierarchically based on level of difficulty. This is a common feature across all cognitive treatments in aphasia. VAT (Helm-Estabrooks et al., 1982) and PSSCogRehab (Bracy, 1994) do not explicitly reference a specific model used to determine their hierarchy, however others such as ATP (Helm-Estabrooks et al., 2000) and APT (Sohlberg & Mateer, 1987) are ordered based on Sohlberg & Mateer's (1987) model of attention. The cognitive models of attention, visual perception, auditory perception and object recognition discussed earlier in Section 4.1 have not been subject to robust evaluation of reliability and validity. They have been designed based on experimental attention literature, clinical observation, and the subjective complaints of people with stroke and TBI. Furthermore, as discussed in Section 2.5, no multi-dimensional model of cognition that includes all the cognitive skills relevant to this intervention has been described in the literature. Ordering the tasks in a hierarchy of difficulty was therefore a challenge. Sohlberg & Mateer (1987) has been referenced in much aphasia literature but has also not been robustly evaluated (see Villard & Kiran, 2017 for a review). For example, Murray et al. (2006) trialled a more advanced version of APT (Sohlberg & Mateer, 1987) called APT-II (Sohlberg et al., 2001) with clients with mild TBI. They found that the intervention's hierarchical organization did not correspond with the degree of difficulty their participant displayed. The participant never met the a priori accuracy criterion on the ‘‘simplest’’ sustained attention task but could complete a mental math task deemed within the manual as more difficult. This highlights the need for more research of the model. Nevertheless, as it is the most accepted model of attention in aphasia, the hierarchy suggested by Sohlberg & Mateer (1987) was incorporated into this novel intervention.

The order of tasks set therefore represents the best approximation of a hierarchical order of complexity based on current literature and clinical experience. Auditory and visual attention are parallel processes, but for the purposes of this intervention where one task is completed at a time, auditory attention and auditory semantic tasks were presented after their visual counterparts. In Chapter 7, the integrity of the hierarchy proposed, and order of the tasks will be discussed.

Table 17 Aims and content of each intervention task

Task	Aim and procedure	Scoring and success criterion	Cognitive skill(s)
1. Visual Tracking	Aim: To follow the movement of a target across a computer screen using eyes. n=16 Target moves across a computer screen in different directions. Eye movement is observed by the researcher and recorded on webcam.	Score of 2 = full tracking Score of 1= partial or delayed eye tracking Score of 0 = no observable eye tracking Total score possible = 32. Success criterion = 90% 29/32	Visual sustained/focused attention Visual scanning
2. Shift gaze -no competing target	Aim: To focus eye gaze on a target then disengage and shift gaze to a different target as original disappears. n=16 Target appears on right or left side of the screen, disappears, then re-appears on opposite side. Eye movement is observed by the researcher and also recorded on a webcam.	Score of 2 = immediate gaze shift Score of 1 = delayed gaze shift Score of 0 = no observable gaze shift Total score possible = 32. Success criterion = 90% 29/32	Visual focused attention Disengage attention Shift attention
3. Shift gaze when there is a competing target	Aim: To focus eye gaze on a target then disengage and shift gaze to look at a different target, while original target remains on the screen. n=16 Target appears on right or left side of the screen, stays in position while another target appears on opposite side. Eye movement is observed by the researcher and also recorded on a webcam.	Score of 2 = immediate gaze shift Score of 1 = delayed gaze shift Score of 0 = no observable gaze shift Total score possible = 32. Success criterion = 90% 29/32	Visual focused attention Disengage attention Shift attention Visual selective attention

4. Visual sustained attention	Aim: To maintain focus and detect an unpredictably occurring visual stimulus. n=10 Target appears in the centre of the computer screen for 2 seconds then disappears for varying amount of time (between 2 and 9 seconds in which the computer screen is blank) then re-appears in the same position. Participant presses the space key on computer keyboard each time the target appears. The computer automatically scores the task.	Score of 1= space key pressed on target Score of 0 = space key not pressed on target (no response). Score of -1 = space key pressed when target not present. Total score possible =10 Success criteria = 9/10	Visual sustained attention
5. Auditory sustained attention	Aim: To maintain focus and detect an unpredictably occurring auditory stimulus n=10. A doorbell sound of 2 second duration is played by the computer while the screen is blank. There is a pause of between 2 and 9 seconds before the same sound is played again. Participant presses the space key on computer keyboard each time the target is heard. The computer automatically scores the task.	Score of 1= space key pressed on target. Score of 0 = space key not pressed on target (no response). Score = -1 space key pressed when target not present. Total score possible =10 Success criteria = 9/10	Auditory sustained attention
6. Object matching	Aim: To match identical objects (n=10) and set foundation for future tasks in the hierarchy that require object recognition. Five real objects are placed in front of the participant. Participant is given one duplicate object identical to one of the five in the array and must place it next to or on top of its counterpart. Array is changed between each target.	Score 1 = correct response Score 0 = no or incorrect response Total score possible =10 Success criteria = 9/10	Visual scanning Visual attention Visual perception: pattern recognition, colour and form

7.	Visual selective attention	Aim: To discretely respond to a target picture and ignore distractors n=10. Target picture is displayed next to laptop. Either the target or a distractor picture (n=20, 10 semantically related distractors and 10 unrelated distractors) appears in the centre of screen one at a time (equal intervals of 2 seconds between each picture). Participant must press the space key on computer keyboard only when a target picture appears. The computer automatically scores the task.	Score of 1 = space key pressed on target Score of 0 = space key not pressed on target (no response). Score = -1 space key pressed when distractor appeared. Total score possible =10 Success criteria = 9/10	Visual perception: pattern recognition, colour and form Visual sustained attention Visual selective attention
8.	Object to non-identical picture matching	Aim: To recognise different exemplars of the same item n=10. Five pictures of different everyday objects are placed in front of the participant. Participant is given one real object that depicts one of the five pictorial items but is not identical to it. They must place the object next to or on top of the corresponding picture. Array is changed between each target.	Score 1 = correct response Score 0 = no or incorrect response Total score possible =10 Success criteria = 9/10	Visual scanning Visual attention Visual perception Visual selective attention Object recognition Visual semantics

9. Gesture to picture matching	Aim: To match an iconic gesture (representing an object's function) to an object picture. n=10 Five pictures of objects are placed in front of the participant. Researcher carries out a gesture (twice) that depicts the use of one of the objects in the array. Participant must point to picture that matches gesture given. Array is changed between each target.	Score 1 = correct response Score 0 = no or incorrect response Total score possible =10 Success criteria = 9/10	Visual scanning Visual attention Visual perception, Visual selective attention Object recognition Visual semantics
10. Match two connected pictures	Aim: To understand semantic relationships and match two semantically related items. n=10. Five pictures are placed in front of a participant. Participant is shown a target picture and must point to a picture from the array that is semantically related to this target (by use or by superordinate category). Array is changed between each target.	Score 1 = correct response Score 0 = no or incorrect response Total score possible =10 Success criteria = 9/10	Visual scanning Visual attention Visual perception, Visual selective attention Object recognition Visual semantics

11. Picture categorisation	Aim: To match items within the same superordinate category, firstly from two unrelated categories (animals and furniture n=10) then two semantically related categories (fruit and vegetables n=10). A picture of one exemplar from each category is placed in front of the participant. Participant is given one picture at a time in a random order (five from each category) and directed to place it underneath or on top of the original exemplar.	Score 1 = correct response Score 0 = no response /incorrect response Total score possible 20 Success criteria = 18/20	Visual attention Visual perception, Visual selective attention Visual recognition Visual semantics
12. Match environmental sound to pictures	Aim: To connect an environmental sound with a picture of an object that makes this sound. n=10. Five pictures are placed in front of the participant. A 3 second sound clip is played from the researcher's iPhone twice. Participant must point to the picture of an object which makes this sound. Array is changed between each target.	Score 1 = correct response Score 0 = no response / incorrect response Total score possible =10 Success criteria = 9/10	Auditory attention (auditory scene analysis) Auditory perception (auditory encoding) Auditory recognition Auditory semantics

13. Odd One Out	Aim: To combine semantic knowledge with problem solving and identify the item that is not semantically related to others. n=10 Three pictures are placed in front of the participant. Two of the three pictures are semantically related by superordinate category and the other is not. Participant must point to the picture which is semantically unrelated to the other two.	Score 1 = correct response Score 0 = no response/ incorrect response Total score possible =10 Success criteria = 9/10	Visual scanning Visual attention Visual perception, Visual selective attention Object recognition Visual semantics Problem solving Pointing
14. Complete the category	Aim: To combine semantic knowledge with problem solving and identify the item that belongs to the same semantic category as two targets. n=10 Two semantically related pictures (from the same superordinate category) are placed in front of participant. Two further pictures are presented, one is from same category as the original two and is the target, and the other is not from the same category.	Score 1 = correct response Score 0 = no or incorrect response Total score possible =10 Success criteria = 9/10	Visual attention Visual perception, Object recognition Visual selective attention Visual Semantics Pointing Problem solving Pointing

15. Choose and Collect a similar item	Aim: To expand visual attention skills across a wide array of items. To select different (non-identical) exemplars of a target item (n=5) from an array of 20 pictures containing 15 randomly mixed distractors. Task is repeated a second time with a different target and exemplars. A random eight distractors are changed between sets, while others remain the same. Participant is given a target picture of an object and must collect from the array of 20 pictures five which depict exemplars of the target and give these pictures to the researcher.	Score 1 = correct response Score 0 = no or incorrect response Total score possible =10 Success criteria = 9/10	Visual scanning Visual attention Visual selective attention Visual perception, Object recognition
16. Choose and Collect from Category	Aim: To use visual attention skills across a wide array of items while also using semantic knowledge. To select items belonging to the same superordinate category as a target (n=5) from an array of 20 pictures containing 15 randomly mixed distractors. Task is repeated a second time with a different target and exemplars. A random eight distractors are changed between sets while others remain the same. Participant is given a target picture of an object and must collect from the array of 20 pictures five that belong to the same category as the target item and give them to the researcher.	Score 1 = correct response Score 0 = no or incorrect response Total score possible =10 Success criteria = 9/10	Visual attention Visual perception, Visual selective attention Object recognition Visual semantics Initiation Choice making

4.3 Intervention materials

The aim was for all object and pictorial items used within the intervention to be familiar, to adults living in the UK. Objects and items were selected according to Snodgrass & Vanderwart's (1980) object familiarity ratings and recommendations. Items within existing clinical tools commonly used in severe and global aphasia such as VAT (Helm-Estabrooks et al., 1982), Language Activity Resource Kit 2 (LARK-2; Dressler, 2005) and Everyday Object Colorcards (Speechmark, 2012) were reviewed. Those that had a mean familiarity rating of above 4 according to Snodgrass & Vanderwart (1980) data were compiled and pictures sourced. Consistent with the subjective considerations of Snodgrass & Vanderwart (1980), an attempt was made to ensure pictures showed the most typical representation of an object, were unambiguous, and included sufficient detail. To this end, pictures were compiled from a variety of sources including, Photo Clip Art (Hemera Technologies, 2002); LARK-2, (Dressler, 2005) and Everyday Object Colorcards (Speechmark, 2012). Wherever, possible the following rules used by Snodgrass & Vanderwart (1980) were also followed when sourcing pictures: animals were shown in sideways view, objects whose up-down orientation may vary were depicted with the functional end down and long, thin objects were oriented at a 45° angle. However, for some items it was not possible to source pictures consistent with these suggestions. For example, the picture of a cat sourced did not meet their criterion. The process of selection led to a set of 43 pictures.

Familiarity with the pictures sourced was confirmed through a questionnaire disseminated to 15 non-brain injured adults aged between 18 and 70. Respondents were asked to rate familiarity with the 43 pictured concepts using the same instructions and definition of familiarity as Snodgrass & Vanderwart (1980). The full questionnaire can be found in Appendix 2. Only items that were rated as highly familiar (5) by at least 80% (12 /15) raters were used in the study. This process resulted in 39 items. These items were randomly allocated to be used as demonstration items, treatment items or assessment items in different tasks. Real objects used in the intervention were taken from the LARK-2 (Dressler, 2005), or if not contained there, sourced by the author for the purpose of this study. Many items were used multiple times (in different tasks) over the course of the intervention, providing participants with additional exposure to particular concepts and increased potential for improvement after the intervention.

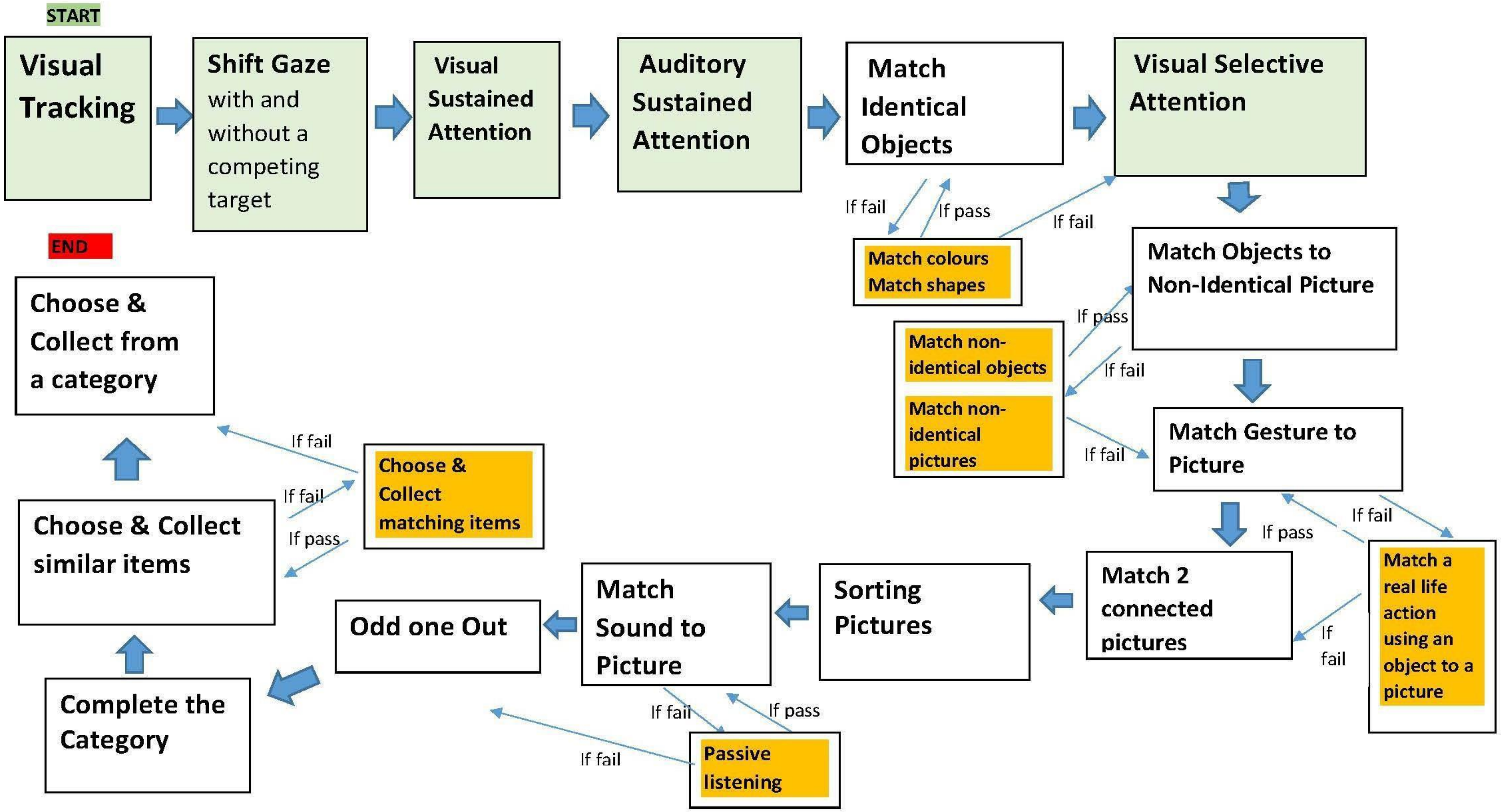
Further processes were developed to determine items to be used within the gesture to picture matching, picture categorisation and environmental sound to picture matching tasks. For the gesture to picture matching task, the researcher determined which of the 39 items chosen could be represented gesturally using an iconic gesture, and a list of 20 objects was generated. Gestures for each of these 20 objects were determined based on the action usually needed to use the item. A video was produced of the researcher gesturing the use of each object. The same 15 non-brain injured adults as above were asked to guess the objects being depicted by the gestures. Eighteen of the 20 gestures were correctly interpreted by 80% or more respondents. These were included in the study as either demonstration, treatment or assessment items. For the picture categorisation task, the categories of fruit, vegetables, animals and furniture were used to represent two semantically related categories and two unrelated categories. Whilst the aim was for categories to be functionally relevant to every-day life, the category of animals was included to represent as separate and distinct a category from the other more functional category (of furniture) as possible. Items chosen were high frequency exemplars of the category according to the data of Van Overschelde, Rawson, & Dunlosky (2004), who produced norms for 70 categories based on data from 300 participants. Given no data exists on familiarity of environmental sounds, for the environmental sound to picture matching task, the entire set of 39 items to be used in the intervention were reviewed, and those that made a sound were considered for potential use. A pragmatic approach was then taken whereby sounds that could easily be sourced through existing clinical tools such as Indoor Sounds Colorcards (Speechmark, 2004a) and Outdoor Sounds Colorcards (Speechmark, 2004b) (which contain picture cards and sound recordings on compact disc) or easily recorded by the researcher were included. Three second clips of each sound were recorded directly onto the researcher's iPhone 5 for use in the environmental sound to picture matching task. Details on the specific items used for each task can be found in Appendix 3. Many items from these sources were also used multiple times (in different tasks) over the course of the intervention. Again, this was to provide participants with additional exposure to particular concepts and increased potential for improvement after the intervention.

4.4 Intervention delivery

The success criterion for each task in the intervention was set at 90% to be consistent with other cognitive interventions such as APT (Sohlberg & Mateer, 1987) and attention training (Sturm et al., 1997). For each task, a participant was provided with two demonstrations then instructed to take their turn. If they failed to achieve 90% on the first attempt, additional support and opportunities for success were provided by following procedures described in Appendix 3 for each task. In summary this support involved the success criterion being reduced from 90% to above chance, and either additional demonstrations being provided or the number of items to choose from being systematically reduced. The initial intervention process allowed up to three opportunities to practice the lowest level of a task before it was abandoned and the participant allowed to move on in the intervention regardless. This was carried out to maximise opportunity for success and avoid the monotony of completing the same tasks repetitively. The aim was to also ensure participants had the opportunity to complete the full programme within the timeframe allocated (18 sessions over 6 weeks). A summary of the intervention process is shown in Figure 6.

After piloting the intervention on the first participant recruited to the study, it was felt that more than three attempts to practice failed tasks was possible and could be beneficial. The pilot participant completed the intervention programme within 15 sessions, despite 18 sessions being available. He failed to reach the success criterion on 10 tasks. Given there were three sessions to spare, it was felt he could have had five attempts at any failed task and still complete the intervention programme within the set timeframe. Therefore, after the pilot participant the intervention process was modified slightly to allow up to five practice attempts at the lowest level of any failed task. The full intervention process is detailed in Appendix 3. The results from the pilot will be detailed in Chapter 6.

Figure 6 Summary of intervention hierarchy and process



Green shaded = computer based task white = paper based task yellow shaded = step down task

4.5 A novel outcome measure- The Interaction Profiling Tool (INTERPReT)

The INTERPReT (Adjei-Nicol et al., n.d.) was developed alongside the intervention during the course of this study. Due to the limitations of existing functional communication assessments for use with PwGA (such as the high linguistic demands and use of a proxy) discussed in Section 2.3, a direct observational measure with simple activities and low linguistic demands was developed. The researcher had completed informal functional assessment of joint attention, turn-taking and problem solving with PwGA in her clinical practice for over 5 years prior to the commencement of this research. This was in the form of observation during activities such as completing jigsaws, playing basic card matching games or Connect4©. During these activities, the researcher observed for skills such as turn-taking and would also include novel elements (such as suggesting two cards matched when they did not during a card game) to determine problem solving abilities. However, these clinical observations were not structured, scored or analysed in a systematic way. For the purpose of this research there was the need to create a structured observational assessment tool that could yield information on basic functional communication skills relevant to PwGA. The researcher consulted with two clinical academic SaLTs and three highly specialist SaLTs to gain an understanding of their practices in directly assessing functional communication in PwGA. All reported using role-play situations. Two reported including novel problem-based scenarios (such as placing a box of tissues near the client with global aphasia, simulating sneezing and then observing whether the client would initiate passing the tissues). None of the experts consulted had documented or published their practices or assessment tools. However, the conversations yielded useful descriptive examples which together with the researcher's own experience formed the basis of the INTERPReT.

It was decided that the INTERPReT would be based around scenarios that had the potential to assess skills directly treated within the intervention and those which may indirectly improve as a result of the intervention. Careful consideration of the skills directly and indirectly targeted in the intervention led to the generation of eleven target behaviours to be assessed. These were the ability to: respond to a social greeting, make a choice in a functional situation, give an accurate yes/no response, share joint focus, understand the basic requirements of an activity, initiate communication, understand specific task rules, notice background noise, continue a task despite background noise, show awareness of a problem, and attempt to rectify a problem.

Scenarios and probes to elicit these behaviours were designed combining the researcher's own clinical experiences, that of the experts who were consulted and the activities survey respondents had reported to use clinically with this population (for example Connect 4™, dominoes and looking through a newspaper or magazine).

The list of probes also functioned as a script for the researcher to follow. To mitigate for learning effects from the INTERPReT being repeated over multiple baselines, three different scenarios with differing activities were designed. An attempt was made for task demands across the three scenarios to be consistent, and for all the scenarios to elicit the same targeted responses. Table 18 details the INTERPReT assessment process, including the 11 target responses to be elicited and the cognitive skills assessed. The full scripts for the three INTERPReT scenarios can be found in Appendix 4.

Table 18 A summary of the INTERPReT assessment procedure and skills measured

Researcher script/ probe provided to participant	**Predicted response by participant**	**Skill(s) assessed**
Greet the client and ask a social question	1. Smiles, verbally or non-verbally responds	Response to social greeting
Offer client a choice of activity **Scenario 1:** Newspaper or magazine **Scenario 2** Jigsaw puzzle or Connect 4™ **Scenario 3** Snap playing card game or dominoes	2. Makes a choice via pointing	Choice making in a functional situation
Ask one basic Yes/No question about the activity e.g. Is that X in the picture? e.g. Is this a yellow piece? e.g. Is it your turn?	3. Gives a correct verbal or non-verbal response	Visual perception Visual semantics Auditory comprehension
Engage in the activity with the client, encourage them to take turns	4. Shares joint focus	Joint attention

	5. Shows general understanding of task e.g. scans pages, takes a turn, places card on pile. 6. Initiates verbal or non-verbal communication during the activity 7. Shows awareness of specific task rules e.g. attempts to turn pages in newspaper, shows awareness when snap cards match.	Visual focused attention Visual sustained attention Turn-taking Initiation of communication / communicative intent Comprehension of task requirements
Present an auditory distraction in background and inform client to ignore this. **Scenario 1** progressively louder knocking on door **Scenario 2** phone ringing for extended period with unusual ring tone **Scenario 3** Alarm clock sound	8. Notices noise 9. Is able to continue with task despite distraction	Auditory perception Auditory selective attention
Present a problem **Scenario 1:** Drop the newspaper or magazine, pick it up and present it to the client upside down	10. Shows awareness of problem for example through facial expression, pointing. 11. Attempts to rectify the problem.	Problem solving

Scenario 2 During jigsaw activity offer the client a piece from a different puzzle that differs significantly in size and colour. or During Connect 4 offer the client a one pound coin rather than red/yellow circle for their turn **Scenario 3** During snap game pretend snap has occurred (i.e. that cards match when they do not) Or During dominoes break the rules and connect two dominoes that clearly have different number of dots.		

4.5.1 Pilot of the INTERPReT

Four SaLTs working in community settings neighbouring the researcher's acute NHS Trust were asked if they were willing to pilot the INTERPReT with at least one client with global aphasia within a 3 week timeframe. The aims of this pilot were to 1) establish whether the script and probes were likely to elicit the target behaviours in PwGA, 2) establish whether the scenarios were at an appropriate level for PwGA to participate in and 3) generate ideas for how to best score the assessment. Three of the four SaLTs agreed to participate. A meeting was arranged in which the researcher explained the content of the INTERPReT and demonstrated administering it in a role play situation with a colleague. The meeting lasted 2 hours and SaLTs were advised to attempt the INTERPReT with at least one client with global aphasia on their caseload. The video recording of sessions was encouraged if possible, and SaLTs were advised that they could prompt or cue clients according to their own clinical judgment consistent with usual clinical practice. The SaLTs were asked to note any issues that arose in following the script and to document client responses with and without cues for each of the 11 targets. They were asked to bring suggestions as to the best way to score or rate responses to the next meeting.

A 3 hour meeting was held 4 weeks after the initial one. The three SaLTs were able to pilot the tool on four PwGA between them during this time. Only one SaLT was able to video their two sessions and these were shown (with clients' consent) during the meeting. The researcher made handwritten notes of key findings and discussion points. The main finding was that all 11 target behaviours were elicited without cueing in at least two of the four clients. The group deemed this result sufficient to satisfy aims 1 and 2 (that the probes and scenarios were appropriate for the client group and had the potential to elicit the target behaviour in PwGA). As a result of this, no changes were made to the assessment script. The next focus of discussion was the participants who either required cueing to elicit the target behaviour or did not demonstrate the target behaviour. A list was made of the cues used by SaLTs. These were: repeating the probe, using facial expression or gesture to aid comprehension, and using hand over hand assistance to support pointing, manipulation of cards or manipulation of game pieces. Examples of the errors made by clients were also discussed and these were noted to be either no response or the client giving an ambiguous non-verbal response that could not be interpreted. As a result of these discussions a scoring system based on the amount of prompting or cueing required to elicit a target response was drafted and agreed by clinical consensus in the meeting. The scoring system is shown in Table 19. A pilot of the tool as a measure of functional communication was conducted within the main intervention study and will be described in Chapter 5. A trained SaLT and a research assistant with a background in Human Communication Science were recruited to be independent raters in the main intervention study. The raters were trained in scoring the assessment using the videos from this piloting process. The videos were then returned to the treating clinician.

Table 19 INTERPReT scoring system

INTERPReT Score	5	4	3	2	1	0
Description	**Does so without prompting.**	**Does so once given minimal prompt.** For example, one repetition.	**Does so once given significant prompts.** For example, multiple repetitions, forced choice, hand over hand assistance.	**Response is ambiguous or difficult to interpret despite prompts.**	**Response is incorrect.**	**Does not demonstrate behaviour.**

4.6 Chapter summary

In summary, a novel intervention programme aimed at improving basic functional communication skills (particularly the ability to understand gesture and make a choice) in global aphasia was developed. The intervention consisted of 16 tasks ordered by level of difficulty and all tasks required no linguistic skills to complete. A process for progressing through the intervention programme was designed with the aim of providing sufficient opportunity for practice and attainment of skill while also giving maximum opportunity for the full intervention to be completed within 18 sessions spread over six weeks.

A novel observational functional communication assessment called the INTERPReT was also developed and piloted by practising SaLTs with four PwGA. A rating system was produced and two independent raters were trained in its use in order to be able to analyse results from the main intervention study. The following chapter will detail the design of the intervention study.

5 Intervention study methodology

The aim of this intervention study is to measure the effect of the novel intervention described in Chapter 4 on the functional communication, cognitive and language skills of six PwGA. The study was a case series with a single subject multiple-baseline ABA design (see Table 20). The design comprised 6 weeks of baseline testing (A_1), followed by 6 weeks of intervention (B) and 2 weeks of post-intervention re-assessment (A_2). After a 3-month no-intervention period, participants were assessed over a 1 week period for maintenance of change (A_3). Primary, secondary and control outcome measures were implemented before and after intervention, and again at maintenance

Specifically, the study aimed to answer the following questions:

- Can a new non-linguistic cognitive intervention change the functional communication skills of PwGA as measured using direct and indirect assessment tools?
- Can a new non-linguistic cognitive intervention change the non-verbal cognitive skills of PwGA, as measured by non-verbal tests of visual perception, visual semantics, auditory semantics, selective attention, problem solving and non-verbal reasoning?
- Is there maintenance of any change in functional communication or cognition after three months?
- Can a new non-linguistic cognitive intervention indirectly change auditory comprehension skills or mood?

This chapter will detail study design methods including information on recruitment, participants and outcome measures.

Table 20 Intervention study design

Week	1-6	**7-12**	13-14	15-24	25
Content	**Baseline Testing**	**Intervention**	**Post Intervention Testing**	**No intervention period**	**Maintenance Testing**
Phase	**A_1**	**B**	**A_2**		**A_3**

5.1 Ethical issues

The study was approved under the Mental Capacity Act (MCA; 2005) by NHS East of England Research Ethics Committee in September 2014 (reference: 14/EE/1076). A substantial amendment to the outcome measurement protocol was later approved by the same ethics committee in June 2015. (see Appendix 5).

All potential participants were deemed by their referring SaLT and the researcher (a qualified SaLT) as lacking capacity to consent to participate. Subsequently, in keeping with Section 32 of the MCA (2005), the researcher (with support of the referring SaLT) identified a personal consultee. This was an individual prepared to give an opinion as to whether the person lacking capacity to consent would want to take part in this research. The consultee was required to know the participant personally (i.e. not in a professional or paid capacity). In accordance with the MCA (2005), the consultee was given written information about their role (see Appendix 6).

The MCA (2005) advises that people lacking consent should be given as much help and support as possible to express their own opinion on participating in research and who should be their consultee. Therefore, an aphasia friendly information sheet for potential participants with global aphasia was developed (see Appendix 7). The researcher used this information sheet to explain the study to PwGA at an initial screening visit (the procedure for this is described in Section 5.2.2). After doing this, verification Yes/No questions were used to check if the potential participant understood the information and could consent themselves. Once confirmed by the researcher that the potential participant with global aphasia was unable to consent, the potential consultee (their relative/friend) was provided with an opportunity to discuss information in the consultee information sheet and also provided with information sheet on their own involvement in the study as a relative/friend of a person with global aphasia (see Appendix 8). Permission was then sought from them to

i) screen the person with global aphasia
ii) act as consultee
iii) participate in the study as a relative/friend of a person with global aphasia.

If relatives/friends were willing to both act as consultee and participate in the study, they were asked to sign two copies of the consultee declaration form (see Appendix 9) and two copies of the consent form for relatives/friends (see Appendix 10).

All activities with participants were conducted over the period September 2014 to June 2016 in accordance with the Data Protection Act 1998 (1998), UCL's Information Security Policy (University College London, 2013) and UCL's Data Protection Policy (University College London, 2010). All personal data was stored on an encrypted hard drive and kept in a locked filing cabinet in a secure access room within UCL. All participants were assigned a pseudonym to be used throughout the study, on materials, in electronic files and during dissemination.

The researcher and referring SaLTs liaised via secure nhs.net email and any personal data transferred by email was done so in a password protected Word document. All emails were deleted after each participant completed the study.

Paper records (assessment score forms and notes on participants' performance in sessions) were kept in a locked filing cabinet in a secure access room within UCL. These records did not have any identifiable information on them and only contained the participant's pseudonym.

Video recorded materials generated during sessions, were uploaded onto an encrypted USB stick and deleted from the video camera before the researcher left the data collection site. These data were uploaded onto an encrypted project hard drive immediately on reaching UCL premises. The material was then deleted from the encrypted USB stick. The hard drive was stored in the same way as paper records, in a locked filing cabinet, in a secure access room within UCL.

5.2 Recruitment

Recruitment took place between September 2014 and June 2015 through SLT services in Greater London who agreed to be a Participant Identification Centre (PIC). Local research and development procedures were followed to gain formal approval for PIC sites.

5.2.1 Inclusion/Exclusion criteria for PwGA

SaLTs at PICs were provided with an SLT Collaborator Information Sheet (see Appendix 11) and asked to identify people on their caseload who met these inclusion criteria:

Adults over 18 years of age who have

- Had at least one stroke (as diagnosed by a physician) of which the most recent was at least 6 months prior to entering the study.
- Global aphasia as diagnosed by a SaLT and characterised by:
    - Little to no verbal output
    - Inconsistent single word comprehension
    - Little to no ability to read/write

Additional communication criteria were:

- Little to no ability to use alternative modes of communication
- Little to no ability to make choices in function
- English as a first language
- No diagnosis of a progressive neurological condition

- No diagnosis or history of depression, mental health condition or hearing loss
- A relative or friend willing to act as consultee

The exclusion criteria were:

- Stroke less than 6 months prior to entering the study
- Not meeting diagnostic characteristics of global aphasia
- Having English as an additional language or having no ability to speak English
- Diagnosed progressive neurological condition
- Diagnosis or history of a mental health condition
- Diagnosed hearing loss

5.2.2 Screening of PwGA

SLT collaborators sent the next of kin of people on their caseload who met the inclusion criteria the following documents:

- A letter of invitation (see Appendix 12)
- An information sheet for relatives/friends of People with Global Aphasia
- Consultee Information sheet
- Participant Information sheet

On receipt of an expression of interest from a relative/friend, the researcher arranged a screening visit with the potential participant and consultee. The consent procedure as detailed in Section 5.1 was followed and in addition the researcher completed the WAB-R Bedside Record Form (Kertesz, 2006) to confirm that the potential participant met the diagnostic criteria for global aphasia. Final confirmation of involvement of both the person with global aphasia and their relative/friend was provided by telephone once the researcher was able to score and check the WAB-R (Kertesz, 2006) bedside record results and liaise with her supervisors if necessary. This was always within 7 days of the visit, and a start date was also agreed during this telephone call.

5.3 Participants

Six participants with global aphasia and their relative/friends were recruited to the study. The first participant (Kevin) piloted the intervention programme as described in Section 4.4. Table 21 provides demographic information on participants with global aphasia, including who their allocated consultee was. All consultees also agreed to participate in the study as a relative/friend of a person with global aphasia.

Results of the WAB-R (Kertesz, 2006) bedside record (completed during screening) and the baseline Pyramids and Palm Trees Test (PPT; Howard & Patterson, 1992) were used for profiling PwGA (see Table 22). All participants had significant language impairments across domains consistent with global aphasia and difficulties completing the PPT (Howard & Patterson, 1992) suggestive of severe visual semantic or task comprehension difficulties.

Table 21 Demographic information on participants

Participant pseudonym	Gender	Age (years)	Type of stroke	Time post stroke	Pre-morbid handedness	Occupation	Consultee allocated	Friend/Relative pseudonym
Kevin (pilot)	Male	72	(1) Left fronto-parietal infarct (2) Left MiCA Infarct	(1) 4 years 7 months (2) 6 years 1 month	Right	Retired builder	Son	Jack
Bernard	Male	57	Left MiCA Infarct	3 years 9 months	Left	Accountant	Friend	Alfie
Peter	Male	61	Left MiCA Infarct	3 years 9 months	Right	Chef	Brother	John
Alan	Male	80	Left Parietal Infarct	6 months	Right	Retired Welder	Wife	Patricia
Ruby	Female	81	Left MiCA Infarct	1 year 3 months	Right	Retired lecturer	Husband	Carl
Henry	Male	58	Left MiCA Infarct	1 year 6 months	Right	Solicitor	Wife	Sarah

MiCA= middle cerebral artery

Table 22 Profiling information for participants with global aphasia

	WAB-R BEDSIDE RECORD FORM (Kertesz, 2006)										**PYRAMIDS AND PALM TREES TEST** (Howard & Patterson, 1992)	
	SSC n=10	SSF n=10	AVC n=10	SC n=10	REP n=10	ON n=10	BAS n=100	WRI n=10	REA n=10	BLS n=100	RS n=52	Observations
Kevin (pilot)	0	0	2	1	1	0	7	0	0	9	0	Selecting all 3 options (target, response and distractor)
Bernard	1	0	3	0	0	0	7	0	0	5	0	Selecting all 3 options (target, response and distractor)
Peter	0	0	2	3	0	0	10	0	0	7.5	6	Giving no response or selecting item on left side
Alan	0	0	5	3	2	0	17	0	0	21	0	No response to each item
Ruby	0	0	0	0	0	0	0	0	0	0	0	No response to each item
Henry	1	0	3	2	2	0	15	0	0	19	0	Selecting all 3 options (target, response and distractor)

SSC= spontaneous speech: content, SSF=spontaneous speech: fluency, AVC= auditory verbal comprehension, SC=sequential commands, REP=repetition, ON=object naming, BAS=bedside aphasia score, WRI=writing, REA=reading, BLS=bedside language score RS=raw score

5.4 Outcome measures

Thirteen outcome measures were used, one primary outcome measure, ten secondary outcome measures, one pilot outcome measure and one control measure. The primary outcome measure in the study was the ASHA-FACS (Frattali et al., 1995) which was completed by a relative/friend. Secondary outcome measures were assessments of non-verbal cognition (visual perception, semantics, selective attention and functional problem solving), language and mood. Some secondary outcome measures were directly linked to tasks within the intervention. These were; object to picture matching, gesture to picture matching, sound to picture matching, picture categorisation, the Flanker Task (Eriksen & Eriksen, 1974), and Butt Non-Verbal Reasoning Test, (BNVRT; Butt & Bucks, 2004). Others were not directly linked to the intervention but measured skills that may change as a result of the intervention. These were the Wisconsin Card Sorting Test -64 card version, (WCST-64; Kongs et al., 2000), and Raven's Coloured Progressive Matrices (RCPM: Raven, Court & Raven, 1990). Auditory comprehension was measured using the subtest from the AST (Whurr, 2011). Mood was measured using the Signs of Depressions Scale (SoDS; Hammond, O'Keeffe, & Barer, 2000) and completed by a relative/friend. As described in Section 4.5.1, the INTERPReT was a novel assessment designed for the purpose of this study. In the main intervention study, it was piloted as a measure of functional communication in global aphasia. The spoken word repetition sub-test from the CAT (Swinburn et al., 2004) was used as a control measure.

At baseline, assessments completed with a significant other or which measured skills indirectly linked to the intervention were completed once, while assessments directly related to the intervention and the control measure were completed three times. All assessments were completed once post intervention. At maintenance only the control measure, primary outcome measure, pilot outcome measure and secondary outcome measures directly linked to the intervention were completed. Table 23 summarises the assessments used and testing schedule.

Table 23 Testing schedule across the study

	B1	B2	B3	P	M
Primary Outcome Measure					
ASHA-FACS	√			√	√
Secondary Outcome Measures					
Object to picture matching	√	√	√	√	√
Gesture to picture matching	√	√	√	√	√
Sound to picture matching	√	√	√	√	√
Picture categorisation	√	√	√	√	√
Flanker Task	√	√	√	√	√
Butt Non-Verbal Reasoning Test	√	√	√	√	√
Wisconsin Card Sorting Test-64	√			√	
Raven's Coloured Progressive Matrices	√			√	
AST: auditory comprehension	√			√	
SoDS	√			√	√
Pilot Outcome Measure					
INTERPReT	√	√	√	√	√
Control Measure					
CAT: Spoken word repetition	√	√	√	√	√

Denotes assessments which were completed with a significant other.
B= baseline P=post intervention, M=maintenance.

5.4.1 Primary outcome measure

The ASHA-FACS (Frattali et al., 1995) assesses 43 communication behaviours (see Appendix 13 for a full list) which are divided into four domains (social communication, communication of basic needs, reading/writing/number concepts, and daily planning). Many of these behaviours relate to non-verbal communication, have low task demands and are relevant to PwGA. For example, the ability to understand facial expressions, tone of voice, and answer yes or no. Each behaviour is rated by a SaLT or significant other on a scale of 1-7 based on communication independence (CI), that is, how much assistance and/or prompting by another person is required to carry it out (see Table

24). A mean CI rating for each of the four domains is used to calculate an overall CI score.

The four domains are then rated on a scale of 1-5 on qualitative communication (QC) dimensions of adequacy (the frequency with which the PwA understands the gist of a message and gets a point across), appropriateness (the frequency with which a PwA's communication is both relevant and carried out under the right circumstances), promptness (the frequency with which the PwA responds without delay and in an efficient manner) and communication sharing (the extent to which the PwA's communication poses a burden to their communication partner). This is summarised in Table 25. A mean QC rating for each dimension is calculated and these scores are used to calculate an overall QC score. Further details on the scoring system for QC can be found in Appendix 14.

Table 24 Communication independence (CI) definitions for the ASHA-FACS Frattali et al., 1995)

CI Score	Definition
7	**Does:** The client performs the communication behaviour, needing no assistance and/or prompting
6	**Does with minimal assistance:** The client performs the communication behaviour, rarely needing assistance and/or prompting.
5	**Does with minimal to moderate assistance:** The client performs the communication behaviour, occasionally needing assistance and/or prompting.
4	**Does with moderate assistance:** The client performs the communication behaviour, often needing assistance and/or prompting.
3	**Does with moderate to maximal assistance:** The client performs the communication behaviour, very frequently needing assistance and/or prompting.
2	**Does with maximal assistance:** The client performs the communication behaviour only with constant assistance and/or prompting.
1	**Does not:** The client does not perform the communication behaviour, even with maximal assistance and/or prompting.

Table 25 Qualitative communication (QC) definitions from the ASHA-FACS (Frattali et al., 1995)

QC Score	Definition
5	Client's communication is **always** adequate/relevant/prompt.
	Client and partner share equally in communication.
4	Client's communication is **often** adequate/relevant/prompt.
	Partner carries little more than half of the communication burden.
3	Client's communication is adequate/relevant/prompt about **half of the time.**
	Partner carries **well over half** of the communication burden.
2	Client's communication is **seldom** adequate/relevant/prompt.
	Partner carries **almost all** of the communication burden.
1	Client's communication is **never** adequate/relevant/prompt.
	Partner carries **all** of the communication burden.

The ASHA-FACS has been robustly field tested in the USA with 131 PwA, 50 of whom had severe aphasia. The overall communication independence and overall qualitative communication scores correlate with the aphasia quotient from the WAB (Kertesz, 1982) and with the comprehension, expression, problem solving, memory and social interaction domains of the Functional Independence Measure (Keith, Granger, Hamilton, & Sherwin, 1987). The ASHA-FACS manual states the assessment can be completed with a significant other as a rater, however field testing has only been completed with SaLTs as raters, and reliability data for its use with significant others is not available. Nevertheless, given the limited number of resources suitable for PwGA, in this study this assessment was completed with the significant other once before intervention, once immediately after intervention and once at maintenance.

5.4.2 Secondary outcome measures of non-verbal cognition

Four tasks completed within the intervention were also completed as outcome measures. These were object to picture matching, gesture to picture matching, environmental sound to picture matching and picture categorisation. These tasks target visual perception and visual and auditory semantic skills. The procedure for completing these tasks was identical to their administration during intervention as described in Table 17 (p.84), but to assess for generalisation, some items used within the assessments were not used within the intervention. Each task was completed three times at baseline, once post intervention and once at maintenance. For each task, one third of items were part of the treatment set and repeated across all baseline assessments, (treated and repeated), one third were not treated in the intervention but tested three times at baseline (untreated and repeated) and one third were not treated in the intervention and not repeated at baseline testing (untreated and unrepeated). Table 26 outlines this process. All treated and untreated items were matched for familiarity using information from the familiarity questionnaire described in Section 4.3 (p.91). The total number of correct items for each task was recorded.

Table 26 Assessment procedure for non-verbal cognitive tasks treated within the intervention

		B1	B2	B3	P	M
Object to picture matching						
Treated Repeated	n=5	√	√	√	√	√
Untreated Repeated	n=5	√	√	√	√	√
Untreated Unrepeated	n=5	√			√	√
Gesture to picture matching						
Treated Repeated	n=5	√	√	√	√	√
Untreated Repeated	n=5	√	√	√	√	√
Untreated Unrepeated	n=5	√			√	√
Sound to picture matching						
Treated Repeated	n=5	√	√	√	√	√
Untreated Repeated	n=5	√	√	√	√	√
Untreated Unrepeated	n=5	√			√	√
Picture Categorisation						
Treated Repeated	n=10	√	√	√	√	√
Untreated Repeated	n=10	√	√	√	√	√
Untreated Unrepeated	n=10	√			√	√

B= baseline, P=post intervention M=maintenance

The Flanker Task (Eriksen & Eriksen, 1974) is an assessment of selective attention and inhibitory control. An online version (Cognitive fun, n.d.) was adapted for use in this study. Three arrows were presented together on a computer screen in a horizontal line. Each arrow was randomly selected by the computer programme to be either pointing left or right. The middle arrow was the target and the other two arrows known as “flankers” were either congruent or incongruent with the middle arrow. The participant was required to focus on the middle target and indicate its direction by pointing to a printed copy of a left or right arrow (the online version uses the left and right keyboard arrow). This adaptation was made to reduce the impact that unfamiliarity with a computer keyboard, visual impairments or hemiplegia may have had. Accuracy in this task has been found to be lower on trials where the ‘flankers’ are incongruent with the target compared to when the flankers are congruent with the target (Ishigami & Klein, 2011). There is limited psychometric data however, Zelazo et al. (2014) found the assessment correlated highly with the Delis-Kaplan Executive Function System (Delis, Kaplan, & Kramer, 2001) an established measure of inhibitory control and executive function. Other assessments of selective attention and inhibitory control with more robust psychometric data do exist, for example, the Stroop Test (Stroop, 1935) and Test of Everyday Attention (Robertson et al., 1994). However, these assessments load heavily on written and oral language skills which would significantly affect performance in global aphasia and for this reason, the Flanker Task was selected. It was completed three times at baseline, once post intervention and once at maintenance. Twenty items were completed and the total correct scored.

The Butt Non-Verbal Reasoning Test (BNVRT; Butt & Bucks, 2004) assesses the ability to problem solve 10 functional scenarios. A photograph depicting a problem is presented alongside four photographically presented potential solutions, one of which is the target solution, one semantically connected to the target, one visually connected to the target and one unrelated. The BNVRT has been deemed a valid assessment of problem solving and can differentiate between healthy controls and stroke patients. Test re-test reliability is also excellent (ICC, 0.97). However, it has been found to correlate highly with the PPT (Howard & Patterson, 1992) and to be indirectly assessing semantic associations as well as problem solving. Nevertheless, this assessment was included because it is the only available non-verbal measure of real-life problem solving and is relevant to the main study aim of improving functional communication. It was conducted three times at baseline, once post intervention and once at maintenance. The total score out of 10 was recorded.

The WCST-64 (Kongs et al., 2000) assesses abstract non-verbal reasoning and ability to shift cognitive strategies in response to changing environmental demands. Sixty-four response cards must be sorted into four piles based on colour, form, shape or a combination of these three characteristics, without the participant knowing the sorting rules. Instead, the participant must determine the correct sorting rule based on feedback from the tester. If and when a participant correctly sorts 10 consecutive cards, the sorting category changes without direct indication. The assessment continues until all 64 cards are used. The full version of the test (Grant & Berg, 1948) has been robustly field tested and found to be a valid measure of executive function.

However, it contains 128 cards and is lengthy to complete. Performance on WCST-64 (Kongs et al., 2000) has been found to correlate highly with the standard version but it is less stable to re-testing. For this reason, in this study it was only completed once at baseline and once post intervention. A variety of scores can be gained from this assessment. For the purpose of this study three scores were calculated; the number of trials to correctly complete the first category, number of categories completed and the overall total number correct.

Raven's Coloured Progressive Matrices (RCPM; Raven, 1956) is a well-known assessment of non-verbal cognitive ability, measuring symbolic thinking and analogical reasoning. Specifically, it tests the ability to make sense of complex shapes and patterns and the ability to perceive new patterns and relationships. The version used in this study (Raven et al., 1990) contains three sections (A, Ab, and B) with 12 items each. A target incomplete design is presented along with six options of designs that could complete the target. The items increase in difficulty within each section. The participant must choose one design to complete the target. Despite its widespread use with adults, the assessment was intended to be used with children and there is limited normative date for older populations and those with brain damage (see for example, Gainotti, Caltagirone, & Miceli, 1977; Villardita, 1985; Kertesz & McCabe, 1975). Completion of the assessment relies heavily on visual spatial skills and overall performance has also been found to be significantly influenced by level of education (Measso et al., 2009). Despite these limitations, the RCPM was chosen because of its non-verbal administration, and extensive use in aphasia research. It was completed once at baseline and once post intervention. Total raw score from a possible 36 was recorded.

5.4.3 Secondary outcome measures of language & mood

The comprehension sub-section of the AST (Whurr, 2011) assesses visual perception, and auditory and written single word and sentence comprehension. By targeting visual perception skills, it can reveal issues with underlying visual cognition that may contribute to performance on this and other assessments. Whilst the entire comprehension sub-section was completed, the specific aim for the study was to establish whether the intervention indirectly improved auditory comprehension. Therefore, only auditory comprehension components were considered, and a score out of 40 recorded.

The Signs of Depression Scale (SoDS; Hammond et al., 2000) is a mood screening assessment used in stroke. It identifies the presence or absence of six low mood behaviours through yes/no questions answered by a proxy. The tool has high sensitivity to identification of low mood and correlates with other well-known assessments of low mood such as the Geriatric Depression Scale (Shah et al., 1997). Low mood is common in post-stroke aphasia (Kauhanen et al., 2000) and associated with poorer functional outcomes (Eriksson, Norrving, Terent, & Stegmayr, 2008). It is therefore relevant to participants in this study with severe impairments and reduced functional abilities. Participation in this study has the potential to influence mood. It may have a positive impact through improvement in skills, regular contact with the researcher and participation in tasks and activities. On the other hand, a negative impact was also possible, for example if participants had difficulties completing tasks and had insight into this or found assessments and tasks monotonous. The SoDS assessment was conducted with a relative/friend at baseline, post intervention and maintenance. Number of low mood behaviours observed (from a possible 6) were scored.

5.4.4 Pilot outcome measure (INTERPReT)

Chapter 4 described the rationale and design process of the INTERPReT (Adjei-Nicol et al, n.d.), which was devised as a direct observational measure of functional communication. Participants were video recorded completing each of the three scenarios (see Section 4.5) with the researcher once at baseline, once immediately after intervention and once at maintenance. Thus, each participant completed a total of nine scenarios.

Two independent raters blinded to the time point at which the assessment was completed analysed videos from three participants each (nine in total) and used the rating scale (see Table 19, p.101) to give a score out of 55.

5.4.5 Control measure

The intervention in this study targeted underlying cognitive skills relevant to functional communication and had the potential to lead to improvement in a range of areas. However, because it was non-linguistic in nature and completed non-verbally, verbal repetition skills were not expected to improve. The single word repetition sub-test of the CAT (Swinburn et al., 2004) was therefore chosen as control measure and was completed three times at baseline, once post intervention and once at follow up. The CAT as a whole has been robustly tested psychometrically and is used widely in clinical practice and research in the UK (see for example, Palmer et al., 2012; Seghier et al., 2016). The verbal repetition sub-test has high test re-test reliability for people with chronic aphasia. It was acknowledged that participants would struggle with this assessment given that, by definition PwGA have limited verbal output. Reading aloud and reading comprehension were considered as control tasks but it was felt that the task demands were higher than for spoken repetition. The participant was required to repeat 16 real words and scored two points for a correct and timely response within 5 seconds, one point for a correct but delayed response (of more than 5 seconds), self-corrected response or if the researcher had to repeat the target, and zero for an inaccurate response. A total score from a possible 32 was calculated.

5.4.6 Assessment procedure summary

The testing schedule for the participants with global aphasia and their relative/friend is shown in Table 27. It was recognised that some flexibility would be needed when testing those with global aphasia because some would fatigue more easily than others, have attention difficulties or find it impossible to participate in some tasks. For example, the researcher may have to allow breaks between tasks or include an extra session to complete an assessment. Where such flexibility was required, tests were always completed in the same week as intended in the testing schedule.

Table 27 Detailed testing schedule for PwGA and their relative/friend.

	Baseline Testing						**Post Intervention Testing**		**Maintenance Testing**
S	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 13**	**Week 14**	**Week 25**
1	AST Repetition	Repetition Flanker Task	INTERPReT Scenario 2 BNVRT	Pic categorisa^{n} Flanker Task	INTERPReT Scenario 3 Pic categorisa^{n}	PPT (35-52) Flanker Task Repetition	AST	WCST-64 INTERPReT Scenario 2	INTERPReT Scenarios 1,2,3 BNVRT
2	RCPM WCST-64	Obj-pic mx Pic categorisa^{n} BNVRT	Sound -pic mx Gest-pic mx PPT (18-34)	Obj-pic mx Gest-pic mx Sound -pic mx	Obj-pic mx Gest-pic mx Sound -pic mx		RCPM	Sound -pic mx Pic categorisa^{n} Repetition	Repetition Obj-pic mx Gest-pic mx
3	INTERPReT Scenario 1 BNVRT PPT (1-17)						INTERPReT Scenario 1 Obj-pic mx Gest-pic mx	INTERPReT Scenario 3 Flanker Task BNVRT	Sound -pic mx Pic categorisa^{n} Flanker Task
	Testing with Relatives/Friends of PwGA								
	Week 1						**Week 13**		**Week 25**
1	ASHA-FACS SoDS						ASHA-FACS SoDS		ASHA-FACS SoDS

S=session obj-pic mx = object to picture matching, Gest-pic mx =gesture to picture matching, Sound-pic mx= environmental sound to picture matching, Pic categorisa^{n}=picture categorisation, PPT=Pyramids and Palm Trees Test (used for participant profiling purposes only as discussed in Section 5.3)

5.5 Intervention session summary

Each participant received three intervention sessions per week lasting between 10 and 60 minutes. The duration of sessions depended on each individual participant's tolerance in terms of engagement, levels of fatigue and attention. The intervention took place across a table in a quiet room in the participant's own place of residence. All intervention sessions were video recorded using a video-camera on a tripod. The video camera was positioned a short distance away between the researcher and participant so as not to distract the participant. Relatives/friends could be present in the session if they or the participant wished but were requested to sit at a distance out of direct view of the camera. They were also reminded to observe only and not prompt, cue or participate in the tasks.

Each session began with the researcher greeting the participant then using gesture and simple language to illustrate that therapy activities would commence. Tasks were completed in the order outlined in Figure 6 and detailed in Section 4.4 with little to no use of verbal language. The researcher gave no specific verbal instructions for the tasks, but instead demonstrated each task using emphasised facial expression and gesture alongside only the following words and phrases: "look (ing)" "this and this", "like this", "together" "here" and "your turn". To give feedback, the researcher used nodding or shaking of the head, thumbs up or down gestures and the words "good", "yes" or "no" to illustrate correct and incorrect responses. At no point during the treatment sessions were item names or categories stated by the researcher.

5.6 Hypotheses and data analysis

The hypotheses to be tested in this case series intervention study were:

- This new non-linguistic cognitive intervention will improve the functional communication skills of PwGA as measured by the ASHA-FACS and INTERPReT.
- Any improvement in functional communication will be maintained 3 months after intervention has ended.
- This new non-linguistic cognitive intervention will improve non-verbal cognitive skills targeted within the intervention (visual perception, auditory semantics, visual semantics, selective attention, functional problem solving), as measured by object to picture matching, gesture to picture matching, sound to picture matching, picture categorisation, the Flanker Task and BNVRT.
- Any improvement in non-verbal cognitive skills targeted in the intervention will be maintained at 3 months after intervention has ended.

- This new non-linguistic cognitive intervention will lead to indirect changes in abstract reasoning, auditory comprehension and mood as measured by the auditory comprehension sub-test of the AST, WCST-64, RCPM and SoDS.
- There will be no change in single word repetition abilities after the intervention as measured by the spoken word repetition sub-test of the CAT.

Case series data was analysed using a combination of qualitative analysis, visual inspection and statistical analysis. Statistical tests of significance were completed using Statistical Package for Social Sciences version 22 (IBM Corp, 2013) with alpha set at 0.05. One tailed significance tests were completed to test directional hypotheses for assessments measuring skills related to the intervention and expected to improve. Treatment studies such as Croot et al. (2015) and Best et al. (2013) have conducted one tailed statistical analyses in this way. Two tailed significance tests were completed to test non-directional hypotheses for assessments measuring skills indirectly related to the intervention.

ASHA-FACS CI and QC scores for each participant at each testing point were plotted on a graph and visual inspection used to determine whether there was improvement, deterioration or no change in performance. Visual analysis of scores for the four domains (social communication, communication of basic needs, daily planning, reading, writing and number concepts) was also carried out and compared within and between participants. Analysis of ASHA-FACS scores focused particularly on the descriptive categories detailed in the assessment and whether changes after intervention led to participants moving from one level to another e.g. from 1 to 2 or 2 to 3 (see Table 24 and Table 25 for a reminder of the descriptive categories). Statistical analysis using a Wilcoxon signed-ranks test was also performed. This was used to determine whether there was a statistically significant median increase in ASHA-FACS score after intervention. For communication independence this involved comparing the baseline rating for each of the 43 behaviours with post intervention and maintenance ratings, whilst for qualitative communication, this involved comparing baseline ratings for the four qualitative dimensions combined (adequacy, appropriateness, promptness, and communication sharing) with post intervention and maintenance ratings.

The analysis of data from the pilot measure (INTERPReT) aimed to aid understanding of its usefulness as a measure of functional communication in global aphasia and to inform any future developments or adaptations that may be required. Overall and individual scenario scores at each time point were tabulated and analysed visually with comparisons made within and between participants. Statistical analysis using a Wilcoxon signed-ranks test was performed for each participant to ascertain if there was a statistically significant median increase in total score (across the three scenarios) for each behaviour, from baseline to post intervention and baseline to maintenance. To assess the inter- and intra-rater reliability of this tool, each rater was asked to select at random and rate three videos from the other rater's set, and three videos from their own set twice.

It is widely accepted that a statistically significant change does not necessarily correspond to clinically important change. The smallest difference in a domain of interest that is perceived as meaningful or beneficial has been referred to as a Minimally Important Difference or Minimally Clinically Important Difference (MCID). Only a few aphasia intervention studies have attempted to quantify this (see for example Guo et al., 2017) but in other areas of rehabilitation such as OT and physiotherapy the use of MCID is more widespread (see for example Wu et al., 2019, Van der Lee et al., 2001). The use of such a measure was included in this study to aid interpretation of clinical significance from data yielded from functional communication measures (the ASHA-FACS and INTERPReT). There is little consensus in the literature as to how the MCID should be calculated. Methods used include arbitrary cut off points based on clinical experience such as 5% (see Kiran & Thompson, 2003), 10% of the total range of measurement (see for example Van der Lee et al., 2001) or using an external measure as an "anchor" or reference (see for example Wu et al., 2019).In this study the MCID was calculated as 10% of the total range of measurement consistent with Van der Lee et al. (2001). Changes in scores at or above this level were deemed clinically significant. The MCID for ASHA-FACS CI which has a range of 1-7 was therefore set at 0.6 points, and for QC which has a range of 1-5, it was set at 0.4 points. Aphasia studies that have used the ASHA-FACS as an outcome measure have not explicitly referenced MCID but have deemed changes lower than those to be used in the current study as important. For example in a study of 14 PwA who received functional intervention known as "Speaking Out", Worrall & Yiu (2000) found a mean improvement of 0.2 points in overall CI. In a single case study of a participant with global aphasia Morrow-Odom & Swann (2013) reported an improvement 0.4 points in overall CI, whilst Hoover, Caplan, Waters, & Carney (2017) reported a mean change of 0.5 points in overall CI in a study of 27 people with chronic aphasia who received intensive aphasia treatment. For each INTERPReT scenario, MCID was set at 5.5. points (10% of the total range which was 55).

For assessments that were completed multiple times at baseline (object to picture matching, gesture to picture matching, sound to picture matching, picture categorisation, single word repetition and BNVRT), Weighted Statistics (WEST; Howard, Best, & Nickels, 2015) were used to examine as a case series, whether there were improvements as a result of the intervention. There are different types of WEST

(Howard et al., 2015), WEST-COL is recommended when there is a stable baseline and assesses whether there is a statistically significant improvement in accuracy after intervention (combining the results of all tests after treatment) compared with accuracy during baseline testing (combining all baseline scores). WEST-ROC is recommended when the baseline testing phase is unstable or when there is improvement during the baseline phase (Howard et al., 2015). It assesses whether there is a significantly greater amount of change after intervention compared with during baseline testing. Both types of WEST involve comparison of the number of times each item in a test was scored as correct over baseline trials with the number of times it was scored as correct on post therapy trials. Howard et al. (2015) suggest statistical methods which include scores of all testing points (rather than for example taking the average or highest baseline score) can prevent the chance of finding a positive effect of treatment when there is none.

The process and instructions for completion of WEST provided by Howard et al. (2015) was followed. In summary, this involved taking one item within the test at a time and multiplying the score from each testing occasion (1 for correct or 0 for incorrect) with a pre-determined weighting factor (which is based on the number of times the particular assessment was conducted) to give a "weighting". This results in each item having five weightings (one weighting per testing point). The five weighting scores are then summed to produce a single number (summed weighting score) for that item. The process is repeated for each item in the assessment. The set of summed weighting scores for all items were then used in a one-sample t test. If baseline testing was stable, WEST COL was used to determine whether there was a significantly better performance in terms of accuracy after intervention (combining post intervention and maintenance performance) than during baseline testing (combing performance across all three baselines). If baseline testing was unstable, WEST ROC was used to determine whether there was a significantly greater amount of change after intervention than during baseline testing. That is whether the change from baseline 3 to post intervention combined with the change from baseline 3 to maintenance is significantly greater than the change from baseline 1 to baseline 2 and baseline 2 to baseline 3 combined. Howard et al. (2015) emphasise the importance of reviewing the direction of any significant result gained from WEST, as it is possible for the result to show that performance was significantly worse after treatment than at baseline. Raw scores were therefore analysed qualitatively to ascertain the direction of change when a significant result was observed.

WEST can also be used to determine if there is a significant difference in the amount of change for different sets of items, for example, between untreated and treated sets.

The method described by Howard et al. (2015), and used by Croot et al. (2015), was followed whereby when WEST statistics identified a significant change in the direction of a treatment effect, generalisation to untreated items was investigated. This was conducted by comparing scores for treated and untreated items using an independent sample t-test. A non-significant result indicated no difference between treated and untreated items and that generalisation to untreated items had occurred.

The McNemar Test was used to measure the effect of intervention on performance on the auditory comprehension sub-test of the AST, RCPM and Flanker Task. It assesses if a statistically significant change in proportions has occurred on a dichotomous trait at two time points on the same population. Each item within these tests was scored as correct or incorrect. For the AST and RCPM, the proportion of correct responses on baseline testing was compared with the proportion of correct responses post intervention. As three baseline measurements were taken for the Flanker Task, the set of responses from a participant's highest scoring performance were compared with the post intervention score. This method was used by Nickels (1992) and recently discussed by (Howard et al., 2015). As the Flanker Task was also assessed at maintenance, performance from baseline was also compared with performance at maintenance testing.

Mood scores from the SoDS (Hammond et al., 2000) were analysed qualitatively for all individual participants, comparing the number of low mood behaviours being demonstrated before and after the intervention.

Results of the intervention study are presented in the following chapter.

6 Intervention Study Results

This chapter will detail the effects of treatment for all participants. All participants completed the assessment schedule as intended (see Table 27). The change in intervention protocol described in Section 4.4, p.93 (whereby participants subsequent to Kevin (the pilot participant) were offered up to five attempts at each task rather than three), was not found to aid performance. Participants continued to fail tasks despite additional attempts. For this reason, Kevin’s data is included in the presentation of results. However, as a reminder of the different treatment protocol he received, his data is depicted differently (for example in grey font or a dashed line on graphs). All participants except Ruby reached the end of the intervention programme within the allocated 6 weeks (18 sessions). The intervention was completed within nine sessions on average (range 5-15), with average session duration ranging from 17 to 54 minutes (see Table 28).

In this chapter, results for the primary outcome measure ASHA-FACS will be reported first (see Section 6.1). Then, secondary outcome measures will be grouped and reported in Section 6.2 according to the skills targeted. Firstly, results for cognitive skills directly treated during intervention are reported i.e. those measured through; object to picture matching, gesture to picture matching, sound to picture matching, picture categorisation, the Flanker Task (Eriksen & Eriksen, 1974) and BNVRT (Butt & Bucks, 2004). Then results for cognitive skills that were not directly trained are provided i.e. those measured using the WCST-64 (Kongs et al., 2000) and RCPM (Raven et al., 1990). Following this, effects on language as measured by the auditory comprehension sub-test of the AST (Whurr, 2011) and changes in mood as measured by SoDS (Hammond et al., 2000) are detailed. Next results of the pilot outcome measure (INTERPReT, Adjei-Nicol et al., n.d.) are reported. Finally performance on the control task, CAT (Swinburn et al., 2004) spoken word repetition sub-test is presented.

Table 28 Intervention session data for each participant

	Number of sessions taken to complete intervention	Average session duration (minutes)	Total amount of intervention received
Bernard	9	43	6 hours 24 minutes
Peter	11	31	5 hours 40 minutes
Alan	6	53	5 hours 18 minutes
Ruby	18 sessions conducted- intervention not completed	17	5 hours 15 minutes
Henry	5	54	4 hours 30 minutes
Kevin	15	19	4 hours 48 minutes

6.1 Primary outcome measures: functional communication

6.1.1 ASHA-FACS Communication independence (CI)

CI as rated by a relative/friend, improved after intervention for all participants except Ruby and the most substantial CI gains were in the subcategory of communication of basic needs. Descriptions for each CI category can be found in Table 24 (p.111). Table 29 details each participant's scores at baseline, post intervention and maintenance for overall CI and each CI sub-category. CI scores for each participant on all 43 behaviours can be found in Appendix 15.

Table 29 Raw communication independence scores for each participant at baseline, post intervention and maintenance.

	Overall communication independence			ASHA-FACS CI Subcategory											
				Social communication			Communication of basic needs			Reading, writing & number concepts			Daily planning		
Participant	**B**	**P**	**M**	**B**	**P**	**M**	**B**	**P**	**M**	**B**	**P**	**M**	**B**	**P**	**M**
Bernard	2.2	3.1	2.8	2.1	3.1	2.6	3.3	5.8	5	1.7	1.6	1.75	1.75	1.75	1.8
Peter	2.3	2.9	2.7	2.65	2.8	2.9	4.6	5.4	5.4	1	1.25	1	1	2	1.6
Alan	1.65	2.4	2.9	2.3	2.3	3	1.9	4.7	5.3	1	1.4	1.6	1.4	1	1.6
Ruby	1.4	1.2	1.1	1.2	1	1	2.2	1.9	1.2	1	1	1	1	1	1
Henry	2.3	3.9	4.3	2.1	3.95	4.6	3.7	5.2	6	2.1	3.3	4.1	1.4	3	5.6
Kevin	1.25	2.4	2	2	2.3	2.4	3	4.6	3.6	1	1.2	1	1	1.4	1.2

B= baseline P= post intervention M= maintenance

CI scores range from 1 (The client **does not** perform behaviours even with maximal assistance and prompting) to 7 (The client **does** perform the communication behaviour, needing **no assistance and/or prompting**). See Table 24 (p.111) for detailed definitions.

Figure 7 illustrates the overall CI scores for all six participants over the course of the study. Using the MCID calculation (see Section 5.5), an improvement of 0.6 or more in overall CI constitutes clinical significance. After intervention, clinically significant gains were observed for five participants (Bernard, Peter Alan, Henry and Kevin). Bernard, Alan, Henry and Kevin all improved by one descriptive category, however Peter did not (see also Table 29). Bernard and Henry moved from level 2 (maximal assistance) to 3 (moderate/ maximal assistance) and Alan and Kevin from 1 (does not perform communication behaviours) to 2 (maximal assistance). A Wilcoxon signed-ranks test showed a statistically significant median increase in CI immediately after intervention compared to baseline for the four participants who improved by one category. (Bernard z=-2.979 p=0.015, one tailed; Alan z=-1.876 p=0.031, one tailed; Henry z=-3.833 p<0.0001, one tailed; Kevin, z=-2.684 p=0.0035, one tailed). Peter's change in score whilst clinically significant did not lead to a change in level. He remained at level 2, (maximal assistance) and the median increase was not statistically significant (z=-1.415 p=0.079 one tailed). Ruby remained in the same descriptive category (level 1) immediately after intervention and a statistically significant median reduction after intervention was noted (z=-1.841, p=0.033 one tailed).

A Wilcoxon signed-ranks test showed a statistically significant median increase in CI at maintenance testing compared to baseline for Bernard (z=-2.787 p=0.0025, one tailed), Alan (z=-3.098 p=0.001, one tailed), Henry (z=-4.741 p<0.001, one tailed) and Kevin (z=-1.795, p=0.035, one tailed) indicating that these participants maintained the gains made immediately after intervention. Figure 7 shows that Alan and Henry's overall CI scores at maintenance were above the levels achieved immediately after intervention (Alan scored 2.4 immediately after intervention and 2.9 at maintenance testing whereas Henry scored 3.9 immediately after intervention and 4.3 at maintenance). Bernard's overall CI score reduced from 3.1 to 2.8 at maintenance but remained above the baseline level (2.2). Kevin's score reduced from 2.4 immediately after intervention to 2 at maintenance but again this was above his baseline score of 1.25. Peter's score reduced from 2.9 immediately after intervention to 2.7 at maintenance. Although Peter's maintenance score was above baseline (2.3), there was not a statistically significant median increase at maintenance compared to baseline (z=-1.512 p=0.0655, one tailed).

Ruby's score reduced from 1.2. immediately after intervention to 1.1 at maintenance. A statistically significant median reduction was observed when baseline and maintenance results were compared (z=-1.89 p=0.03 one tailed).

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Figure 7 ASHA-FACS overall communication independence scores for each participant at baseline, post intervention and maintenance.

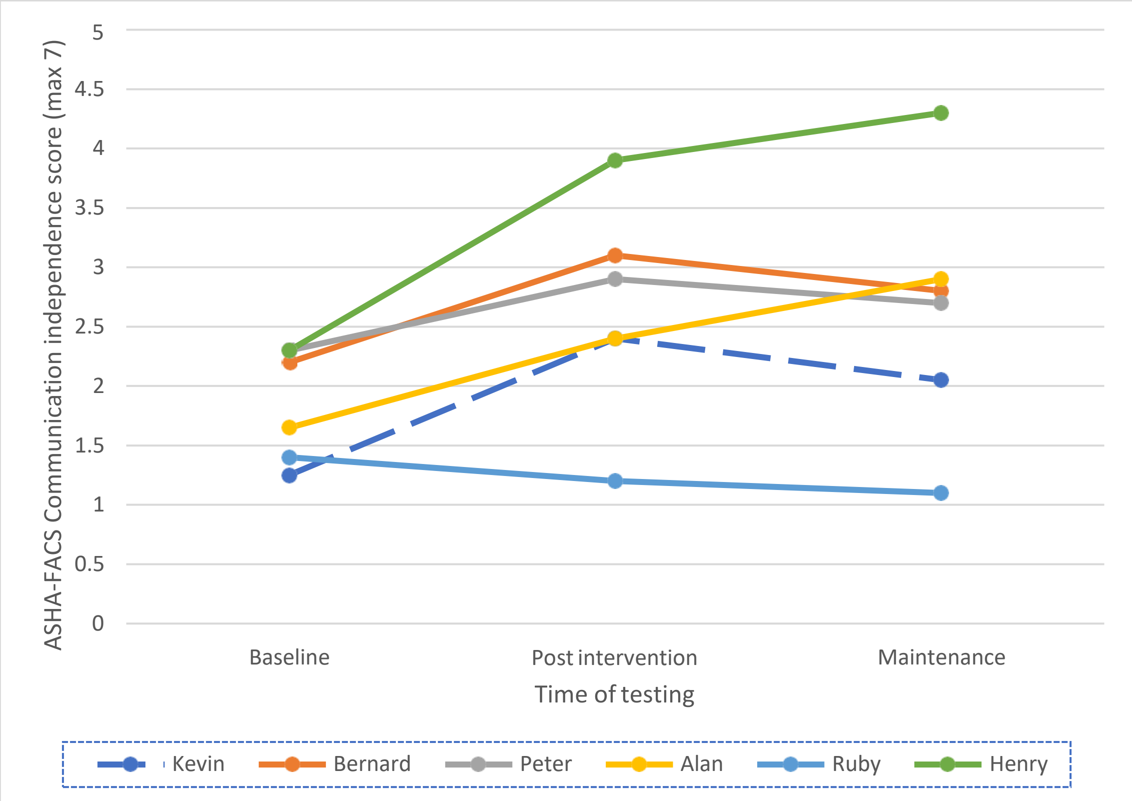


Table 29 further reveals that after intervention, all participants except Ruby made clinically significant gains in communicating basic needs, with Alan improving by 2.8 points, Bernard, Henry by 1.5 points, Peter by 0.8 points and Kevin by 1.6 points. Bernard and Henry also made gains of 1 point and 1.85 points respectively in social communication after intervention. Henry was the only participant to make clinically significant gains in the subcategory of reading, writing and number concepts. His score increased by 1.2 after intervention and by a further 0.8 at maintenance. Only Henry and Peter made clinically significant gains in daily planning. Henry's score increased by 1.6 after intervention and a further 2.6 at maintenance, Peter's score increased by 1 point after intervention but deteriorated by 0.4 points by the maintenance phase.

6.1.2 ASHA-FACS Qualitative communication (QC)

Overall QC as rated by a relative/friend, improved after intervention for all participants except Ruby. Descriptions for each QC category can be found in Table 25 (p.112). Table 30 details each participant's scores at baseline, post intervention and maintenance phases for overall QC and each QC subcategory. QC scores for each participant on each of the four domains measured can be found in Appendix 16.

Table 30 Raw qualitative communication scores for each participant at baseline, post intervention and maintenance.

	Overall qualitative communication			**ASHA-FACS QC Subcategory**												
				Adequacy			**Appropriateness**			**Promptness**			**Communication sharing**		
Participant	**B**	**P**	**M**	**B**	**P**	**M**	**B**	**P**	**M**	**B**	**P**	**M**	**B**	**P**	**M**
Bernard	2.2	2.6	2.8	2	2.5	2.75	2.25	2.5	3	2	2.5	2.75	2.5	3	3.5
Peter	2.3	2.4	2.5	2.5	2.25	2.5	2.3	2.5	2.75	2	2.23	2.25	2.5	2.5	2.5
Alan	1.57	2.75	2.7	1.8	2.5	2.5	1.5	2.75	2.75	1.5	2.75	3	1.25	2.75	2.5
Ruby	1	1	1	1.25	1	1	1.25	1	1	1.25	1	1	1	1	1
Henry	2.13	3.25	3.6	2.5	3.75	3.5	2	3.5	4	2	2.75	3.5	1	3	3.5
Kevin	2	2.63	2.4	1.75	2.75	2.5	2	2.5	2.5	1.75	2.25	2.25	2.5	3	2.5

B= baseline P= post intervention M= maintenance

QC score ranges from 1 (Client's communication is **never** adequate/relevant/prompt, Partner carries **all** of the communication burden) to 5 (Client's communication is **always** adequate/relevant/prompt, Client and partner share equally in communication). See Table 25 (p.112) for detailed definitions.

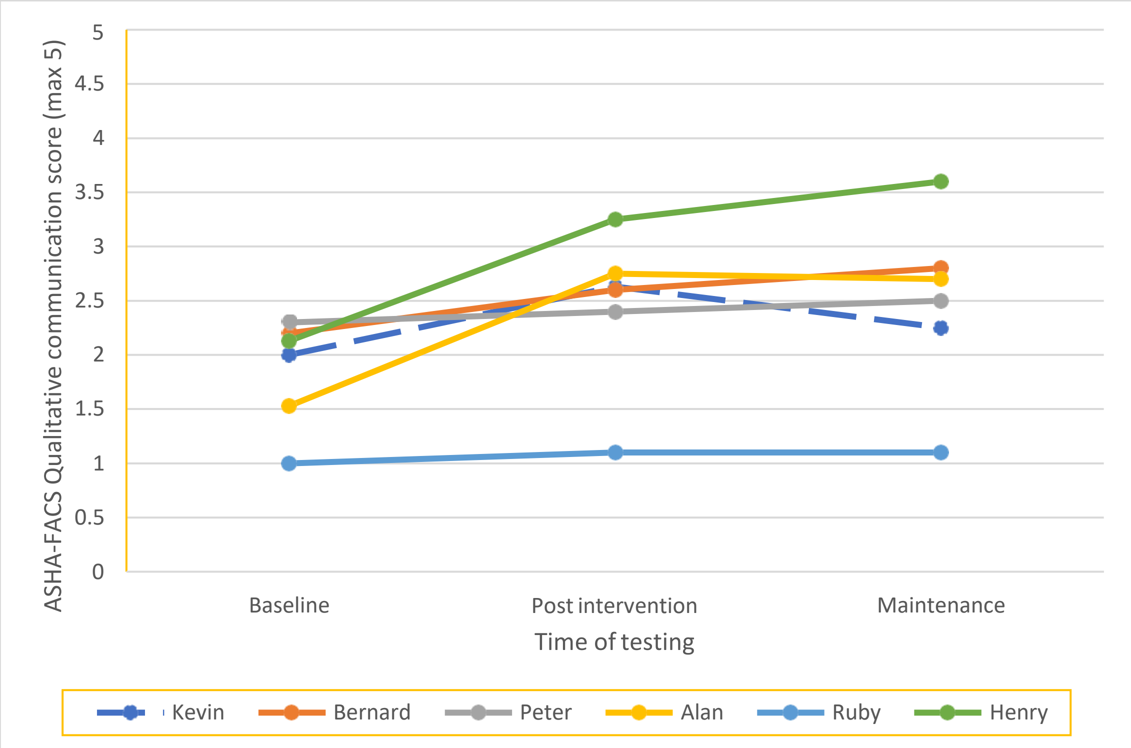
Figure 8 illustrates the overall QC scores for all six participants over the course of the study. Using the MCID calculation (Section 5.5), an improvement of 0.4 or more in overall QC constitutes clinical significance. Bernard, Alan, Henry and Kevin made clinically significant improvements in overall QC after intervention (see also Table 30). However only Alan, Henry and Kevin showed a statistically significant median increase after intervention. Alan's overall QC improved by one descriptive category from level 1 to 2 (never adequate/relevant/prompt to seldom adequate/relevant/prompt) (z=-2.863 p=0.002, one tailed). Henry's overall QC improved from level 2 to 3 (seldom adequate/relevant/prompt to about half the time) (z=-3.358 p=0.0005, one tailed). Kevin improved by 0.6 points and demonstrated a statistically significant median increase (z=-3.000 p=0.002, one tailed), but he remained within the same category (level 2, seldom adequate/relevant/prompt). Alan, Henry and Kevin were found to maintain these gains. Statistically significant median increases were found when baseline and maintenance scores were compared (Alan z=-2.707 p=0.0035, one tailed; Henry z=-3.115 p=0.001, one tailed; Kevin z=-2.111 p=0.018, one tailed).

Bernard's overall QC increased by 0.4 immediately after intervention but with no change in descriptive category (level 2, seldom adequate/relevant/prompt) and a trend towards a statistically significant median increase was observed (z=-1.633 p=0.051, one tailed). However, when baseline results were compared to maintenance, a statistically significant median increase was noted (z=-3 p=0.0015, one tailed). Table 30 highlights Bernard's score increased from 2.2 at baseline to 2.6 immediately after intervention and to 2.8 at maintenance.

Peter's QC score increased from 2.3 at baseline to 2.4 immediately after intervention and 2.5 at maintenance (see Table 30). He remained within level 2, (seldom adequate/relevant/prompt) over the course of the study. A statistically significant median increase was not noted immediately after intervention (z=-0.577 p=0.282, one tailed). However, when baseline results were compared to maintenance a statistically significant median increase was noted (z=-1.732 p=0.042, one tailed).

Ruby's score did not change over the course of the study (1, never adequate/relevant/prompt) and statistically significant median increases were not noted immediately after intervention (z=0 p=0.5, one tailed) or at maintenance (z=0 p=0.5, one tailed).

Figure 8 ASHA-FACS overall qualitative communication scores at baseline, post intervention and maintenance for each participant



The MCID calculation (see Section 5.5) was also used to quantify clinically significant gains in QC sub-categories. An improvement of 0.4 or more in any QC sub-category also constitutes clinical significance. Table 30 reveals that that immediately after intervention Alan, Henry and Kevin made clinically significant gains in all four QC subcategories of adequacy, appropriateness, promptness and communication sharing. Bernard made clinically significant gains in adequacy, promptness and communication sharing but not in appropriateness.

In adequacy of communication, Bernard improved by 0.5 points, Alan by 0.7 points, Henry by 1.25 points, and Kevin by 1 point. Whilst Bernard's score increased by a further 0.25 at maintenance, Alan's score remained the same and both Henry's and Kevin's scores deteriorated by 0.25 points.

For appropriateness, Alan's score improved by 1.25 points, Henry's by 1.5 points and Kevin's by 0.5 points. Bernard's score improved by only 0.25 immediately after the intervention not constituting clinical significance but by maintenance improved by 0.5 into the next descriptive category which is a clinically significant improvement. At maintenance Henry's performance also further improved by 0.5 points and moved into the next category, whilst Peter's performance improved by 0.25 points and Alan and Kevin's scores remained the same.

For promptness, immediately after intervention Bernard improved by 0.5 points, Alan by 1.25 points, Henry by 0.75 points and Kevin by 0.5 points whilst Peter's improvement was not clinically significant. At maintenance Bernard and Alan's score increased by 0.25 points and Henry's score increased by 0.75. Kevin's score remained the same.

In communication sharing after intervention, Bernard improved by 0.5 points, Alan by 1.5 points, Henry by 2 points and Kevin by 0.5 points. At maintenance Bernard and Henry's score increased by 0.5 points, whilst Alan's score deteriorated by 0.25. Kevin's score deteriorated by 0.5 back to its baseline level.

6.1.3 Summary of results for primary outcome measure (ASHA-FACS)

The intervention led to improvement in functional communication as measured by a proxy (relative/friend) for all but one participant. Five participants made clinically significant gains in CI after intervention, with gains most notably demonstrated in the sub-domain of communication of basic needs. For four of these participants gains made were also found to be statistically significant and maintained at follow up.

Four participants made clinically significant gains in overall QC with all four making gains in adequacy, promptness of communication and the level of communication burden carried by a communication partner. For three of these participants gains made were also found to be statistically significant and maintained at follow up.

6.2 Secondary outcome measures: cognition and language

6.2.1 Non-verbal visual perception and semantic tasks treated within the intervention

Weighted statistics (WEST; Howard et al., 2015) were used to determine the effect of intervention on non-verbal visual perceptual and semantic skills as measured by; object to picture matching, gesture to picture matching, sound to picture matching and picture categorisation. As detailed in Section 5.5, when baseline testing was deemed stable WEST-COL was used to determine whether there was a significantly greater improvement in accuracy after intervention (post intervention and maintenance combined) than during the baseline testing phase (B1, B2, B3 combined). If baseline testing was unstable, WEST ROC was used to determine whether there was a significantly greater amount of change after intervention (between B3 and P and B3 and M) than during the baseline testing phase (between B1 and B2, and B2 and B3). When a statistically significant improvement or change was noted, raw scores were reviewed to ascertain the direction of this. If improvement as a result of the intervention was observed (accuracy or change after intervention was greater than accuracy or change at baseline), a post-hoc t test was completed to determine whether there was a significant difference between treated and untreated items. A non-significant difference between treated and untreated items suggests generalisation to untreated items has occurred.

Table 31 provides raw data for each participant. For ease of interpretation, given the different number of items used at each testing point, scores are provided in percentages. Table 31 highlights that performance at baseline was often unstable. Kevin showed a particularly variable performance across tasks and all participants showed variability on the picture categorisation task. Table 32 details the results of statistical testing using WEST. The table highlights that due to instability of baseline testing scores, WEST-ROC was used more frequently for analysis than WEST-COL.

On object to picture matching, significant improvements were noted for Ruby and Kevin. Ruby showed greater accuracy after intervention than at baseline. (WEST-COL: t(14)=2.168 p=0.024, one tailed), consistently scored 0 at baseline but 3/15 (20%) post intervention and 4/15 (27%) at maintenance. Kevin showed a greater amount of change after intervention than during baseline testing (WEST-ROC: t(14)=4.113 p=0.0005, one tailed), scoring 2/15(13%), 0/10, 0/10 at baseline, 9/15 (60%) post intervention and 6/15 (40%) at maintenance. The results of post hoc t-tests (see Table 32) show no significant difference between treated and untreated items for both Ruby (t(13)=0.425 p=0.678, two tailed) and Kevin (t(13)=1.14 p=0.273, two tailed) suggesting that generalisation to untreated items occurred. Alan and Henry scored at ceiling across testing points and Bernard and Peter did not show a statistically significant difference between baseline and post intervention performance.

On gesture to picture matching, significant improvements were noted for Bernard and Peter. Both showed a greater amount of change after intervention than at baseline. For Bernard WEST-ROC t(14)=2.328 p=0.0175, one tailed and raw data (see Table 31) shows at baseline he scored 12/15(80%), 8/10(80%, 5/10(50%) and post intervention 13/15 (87%) and at maintenance 11/15 (73%). For Peter WEST-ROC t(14)=1.827 p=0.045 one tailed, and raw data shows at baseline he scored 10/15 (67%), 6/10(60%) and 4/10 (40%), post intervention 12/15 (80%) and 9/15 (60%). Whilst a statistically significant result was noted for Kevin (WEST-ROC was t(14)=2.412 p=0.014, one tailed), Table 31 shows that improvement was in the opposite direction to Bernard and Peter. Kevin showed a greater deterioration (rather than improvement) after intervention, scoring 3/15(20%), 3/10(30%) and 3/10(30%) at baseline, 1/15 (6.7%) post intervention and at maintenance 2/15(13%). Post hoc t-tests conducted on Bernard and Peter's data were not significant (Bernard (t(13)=0.733 p-0.367 two tailed, Peter (t(13)=0.949 p=0.36, two tailed) indicating no difference between amount of change for treated and treated items and that generalisation to untreated items occurred. Ruby scored at floor across testing points on this task, while Alan and Henry did not show a greater amount of change after intervention than at baseline.

On sound to picture matching a significant improvement was only noted for Peter. He showed a greater amount of change after intervention than during baseline testing (WEST-ROC $t(14)=1.781$ $p=0.049$, one tailed) (see Table 32). Raw data (see Table 31) shows he scored 7/15 (47%), 6/10 (60%) and 5/10 (50%) at baseline, 6/15 (40%) post intervention and 10/15 (67%) at maintenance. A post hoc t-test was not significant ($t(13)=0.926$, $p=0.371$ two tailed) indicating no significant difference between amount of change for treated and untreated items and that generalisation to untreated items occurred. Ruby scored at floor across all testing points on this task and for Bernard, Alan, Henry and Kevin there was no significant difference in the amount of change at baseline compared to after intervention.

On picture categorisation four participants (Peter, Alan, Ruby and Kevin) showed a greater amount of positive change after intervention than at baseline (see Table 32). For Peter WEST-ROC was $t(29)=5.198$ $p<0.001$, one tailed, and he scored 23/30(77%), 8/20(40%), 5/20(25%) at baseline, 29/30 (97%) post intervention and 27/30(90%) at maintenance. For Alan WEST-ROC was $t(29)=5.64$, $p<0.001$, one tailed and he scored 27/30 (90%), 19/20 (95%), 4/20 (20%) at baseline. 29/30 (97%) post intervention and 30/30 100% at maintenance. For Ruby WEST-ROC was $t(29)=2.303$ $p=0.0145$, one tailed and she scored 6/30 (20%), 0/20, 1/20 (5%) at baseline, 8/30 (27%) post intervention and 2/30 6.7% at maintenance. For Kevin WEST-ROC was $t(29)=2.397$ $p<0.001$, one tailed and he scored 15/30 (50%), 11/20 (55%), 9/20 (45%) at baseline followed by 21/30 (70%) post intervention and 15/30 (50%) at maintenance. Bernard on the other hand showed a greater amount of change in the opposite direction, WEST-ROC was $t(29)=1.955$ $p=0.034$ one tailed, showing a greater amount of change during baseline testing (scoring 17/30 (57%), 6/20 (30%), 18/20 (90%) than after intervention (scoring 28/30, 87% post intervention and 23/30, 77% at maintenance). Henry scored at ceiling across testing points. Post hoc t-tests were not significant for Alan ($t(28)=0.32$, $p=0.752$ two tailed), Ruby ($t(28)=0.425$, $p=0.678$,two tailed) or Kevin ($t(28)=2.026$, $p=0.062$) indicating generalisation to untreated items occurred for these participants. However, generalisation did not occur for Peter as a significant difference between treated and untreated sets was noted ($t(28)=4.853$, $p<0.001$, two tailed).

Table 31 Raw scores for each participant on non-verbal visual perceptual and semantic tasks treated in the intervention

	Object to picture matching					**Gesture to picture matching**					**Sound to picture matching**					**Picture Categorisation**				
	B1	B2	B3	P	M	B1	B2	B3	P	M	B1	B2	B3	P	M	B1	B2	B3	P	M
Pa	n=15	n=10	n=10	n=15	n=15	n=15	n=10	n=10	n=15	n=15	n=15	n=10	n=10	n=15	n=15	n=30	n=20	n=20	n=30	n=30
Be	**14**	**9**	**9**	**15**	**13**	**12**	**8**	**5**	**13**	**11**	**11**	**8**	**9**	**8**	**10**	**17**	**6**	**18**	**26**	**23**
%	93	90	90	100	87	80	80	50	87	73	73	80	90	53	67	57	30	90	87	77
Pe	**9**	**2**	**6**	**13**	**13**	**10**	**6**	**4**	**12**	**9**	**7**	**6**	**5**	**6**	**10**	**23**	**8**	**5**	**29**	**27**
%	90	**20**	60	87	87	67	60	40	80	60	47	60	50	40	67	77	40	25	97	90
A	**15**	**10**	**10**	**15**	**15**	**11**	**8**	**7**	**10**	**11**	**8**	**5**	**6**	**5**	**5**	**27**	**19**	**4**	**29**	**30**
%	100	100	100	100	100	73	80	70	67	73	55	50	60	33	33	90	95	20	97	100
R	**0**	**0**	**0**	**3**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**1**	**8**	**2**
%	0	0	0	20	27	0	0	0	0	0	0	0	0	0	0	20	0	5	27	6.7
H	**15**	**10**	**10**	**15**	**15**	**13**	**4**	**7**	**10**	**11**	**11**	**9**	**8**	**13**	**11**	**30**	**20**	**20**	**30**	**30**
%	100	100	100	100	100	87	40	70	67	73	73	90	80	87	73	100	100	100	100	100
K	**2**	**0**	**0**	**9**	**6**	**2**	**3**	**3**	**1**	**2**	**3**	**3**	**5**	**6**	**4**	**15**	**11**	**9**	**21**	**15**
%	13	0	0	60	40	13	30	30	7	13	20	30	50	40	27	50	55	45	70	50

B=baseline P=post intervention M=maintenance Pa= participant Be=Bernard, Pe=Peter A=Alan R=Ruby H=Henry K=Kevin

Table 32 Results of statistical testing for non-verbal visual perceptual and semantic tasks treated within the intervention

	Object to picture matching			Gesture to picture matching			Sound to picture matching			Picture categorisation		
Pa	t	p value (one tailed)	post-hoc t test (two tailed)	t	p value (one tailed)	post-hoc t test (two tailed)	t	p value (one tailed)	post-hoc t test (two tailed)	t	p value (one tailed)	post-hoc t test (two tailed)
Be	0 df(14)	p=0.5 n.s. WEST-COL	-	2.328 df(14)	**p=0.0175*** WEST-ROC	t=0.733 df(13) **p=0.367 n.s.^**	-1.597 df(14)	p=0.0665 n.s. WEST-ROC	-	1.955 df(29)	**p=0.034*** WEST-ROC	-
Pe	1.578 df(14)	p=0.069 n.s. WEST-ROC	-	1.827 df(14)	**p=0.045*** WEST-ROC	t=0.949 df(13) **p=0.36 n.s.^**	1.781 df(14)	**p=0.049*** WEST-ROC	t=0.926 df(13) **p=0.371 n.s.^**	5.198 df(29)	**p<0.001*** WEST-ROC	t=4.853 df(28) p<0.001*
A	scored at ceiling across testing points			0.308 df(14)	p=0.382 n.s. WEST-ROC	-	0.314 df(14)	p=0.379 n.s. WEST-ROC	-	5.64 df(29)	**p<0.001*** WEST-ROC	t=0.32 df(28) **p=0.752 n.s.^**
R	2.168 df(14)	**p=0.024*** WEST-COL	t=0.425 df(13) **p=0.678 n.s.^**	scored at floor across testing points			scored at floor across testing points			2.303 df(29)	**p=0.0145*** WEST-ROC	t=0.425 df(28) **p=0.678 n.s.^**
H	scored at ceiling across testing points			0.111 df(14)	p=0.457 n.s. WEST-ROC	**-**	1.108 df(14)	p=0.143 n.s. WEST-ROC	-	scored at ceiling across testing points		
K	4.113 df14)	**p=0.0005*** WEST-ROC	t=1.14 df(13) **p=0.273 n.s.^**	-2.412 df(14)	**p=0.014*** WEST-ROC	**-**	-2.452 df(14)	p=0.143 n.s. WEST-ROC	-	2.397 df(29)	**p<0.001*** WEST-ROC	t=2.026 df(28) **p=0.062 n.s.^**

Be=Bernard Pe=Peter A=Alan R=Ruby H=Henry K=Kevin

Bold font with * indicates a statistically significant result **bold font with ^** indicates generalisation to untreated items has occurred.

6.2.2 Attention

Table 33 details selective attention scores as measured by the Flanker Task (Eriksen & Eriksen, 1974), for each participant at baseline, post intervention and maintenance. Baseline scores varied within participants particularly for Alan who scored 5/20, 17/20 and 12/20 across baseline tests. The proportion of correct responses for Henry were observed to significantly improve after the intervention and he maintained these gains at follow up (McNemar Test, p=0.002 after intervention and at maintenance). Henry scored 11/20, 10/20, 11/20 at baseline then 20/20 post intervention and at maintenance. Bernard, Peter, Alan and Kevin did not show statistically significant increases in the proportion of correct responses after intervention. Kevin was seen to improve from being unable to complete the task at baseline (scoring 0/20) to scoring 2/20 post intervention. The Flanker Task requires a participant to choose the direction of an arrow from a choice of two for 20 items. A chance score is therefore 10/20. Kevin's small change may not represent improvement in actual selective attention skills as his score is still well below chance. Ruby scored at floor across testing points.

Table 33 Raw scores and results of statistical testing for selective attention as measured by the Flanker Task

Participant	**B1 n=20**	**B2 n=20**	**B3 n=20**	**P n=20**	**M n=20**	**Highest baseline to post intervention comparison with McNemar. p value (one tailed)**	**Highest baseline to maintenance comparison with McNemar. p value (one tailed)**
Bernard	14	12	11	15	12	p=0.5	p=0.3125 n.s.
Peter	4	2	0	0	5	p=0.6	p=0.5 n.s
Alan	5	17	12	14	20	p=0.25	p=0.125 n.s.
Ruby	0	0	0	0	0	n/a	n/a
Henry	11	10	11	20	20	**p=0.002***	**p=0.002***
Kevin	0	0	0	2	0	P=0.25	n/a

B=baseline P=post intervention M= maintenance * indicates a statistically significant result

Analysis of errors within this task (see Table 34) highlights that participants made more errors when the direction of the target arrow was incongruent with the arrows flanking it. A discrepancy in performance between congruent and incongruent targets indicates difficulties with selective attention. All participants except Ruby showed improvement in score or a change in pattern of performance across the study.

Table 34 Number of errors made on congruent and incongruent targets by each participant on the Flanker Task

	B1		**B2**		**B3**		**P**		**M**	
	C	I	C	I	C	I	C	I	C	I
	Number of errors for each type of target (n=10)									
Bernard	0	6	3	5	0	9	0	5	0	8
Peter	6	10	8	10	10	10	Ambiguous		5	10
	Includes ambiguous		Includes ambiguous		Includes ambiguous					
Alan	8	7	1	2	3	5	0	6	0	0
Ruby	No response		No response		No response		No response		No response	
Henry	0	9	0	10	0	9	0	0	0	0
Kevin	Ambiguous		Ambiguous		Ambiguous		8	10	10	10

B=baseline P=post intervention M= maintenance C=target congruent with flankers I=target incongruent with flankers No response=no attempt made Ambiguous responses= participant pointed at more than one arrow

At baseline, Bernard, Alan and Henry had the highest scores. However, none of them performed without error. They all made more errors with incongruent stimuli than with congruent stimuli. Immediately after intervention Bernard no longer made any congruent errors but incongruent errors were still present, and he demonstrated the same pattern at maintenance. Immediately after intervention Alan also no longer made congruent errors but persisted with incongruent errors. However, by maintenance he was scoring at ceiling with no errors. Henry only made incongruent errors at baseline and after intervention made no errors.

Peter's error pattern at baseline included errors with both congruent and incongruent stimuli and some ambiguous responses whereby he pointed at both left and right arrow options. Immediately after intervention Peter's responses were persistently ambiguous suggesting a deterioration in task comprehension. By maintenance he was consistently providing one response suggesting some improvement in task comprehension.

However, he made errors with all incongruent items and only correctly responded to half of the congruent targets.

Ruby scored at floor on each attempt at this task, giving no response each time.

Kevin scored at floor across all three baselines. He did not demonstrate understanding of the task requirements and pointed at both left and right arrow options each time (ambiguous errors). After intervention, Kevin's responses were no longer ambiguous, however there were a large number of errors across both incongruent and congruent targets.

6.2.3 Non-verbal reasoning and problem solving

Performances across three assessments of non-verbal reasoning and problem solving were analysed. These were BNVRT (Butt & Bucks, 2004), RCPM (Raven et al., 1990) and WCST-64 (Kongs et al., 2000). No participant showed improvements on all three assessments. On the BNVRT only Bernard's performance demonstrated statistically significant improvements as a result of intervention (WEST-ROC t(9)=3.073, p=0.0065 one tailed). Table 35 shows that his scores improved from 0/10, 2/20, 0/10 at baseline to 7/10 post intervention and 5/10 at maintenance, therefore the amount of change after intervention was greater than the amount of change at baseline. Peter, Alan, Henry and Kevin did not show greater amount of improvement or change after intervention than at baseline, and Ruby scored at floor at all testing points.

Table 35 Raw scores and results of statistical testing for non-verbal problem solving as measured by the BNVRT

Participant	B1 n=10	B2 n=10	B3 n=10	P n=10	M n=10	Statistic	t	p value (one tailed)
Bernard	0	2	0	7	5	WEST-ROC	3.073 df(9)	**p=0.0065***
Peter	6	5	5	7	5	WEST-ROC	0.830 df(9)	p=0.214 n.s.
Alan	5	7	8	6	7	WEST-ROC	-1.049 df(9)	p=0.322 n.s.
Ruby	0	0	0	0	0	n/a		
Henry	7	7	7	9	9	WEST-COL	1.309 df(9)	p=0.112 n.s.
Kevin	0	1	0	1	0	WEST-ROC	0.612 df(9)	p=0.2775 n.s.

B= baseline P= post intervention M=maintenance * indicates a statistically significant result

Table 36 shows that on the RCPM, only Bernard and Henry demonstrated a statistically significant difference in the proportion of correct responses post intervention (p=0.002, two tailed for both participants). Raw scores highlight that both of their scores increased after the intervention, Bernard's score increased from 4/36 to

14/36 and Henry's score from 20/36 to 31/36. The proportion of correct responses for Peter, Alan and Kevin post intervention were not significantly different to baseline, and Ruby scored at floor both at baseline and post intervention.

Table 36 Raw scores and results of statistical testing for non-verbal reasoning as measured by the RCPM

	B n=36	P n=36	McNemar p value (two tailed)
Bernard	4	14	**p=0.002***
Peter	3	7	p=0.216 n.s
Alan	27	28	p=1 n.s
Ruby	0	0	n/a
Henry	20	31	**p=0.002***
Kevin	1	7	p=0.7 n.s.

B= baseline P= post intervention * indicates a statistically significant result

The WCST-64 (Kongs et al., 2000) appeared to be too difficult for many participants. Neither Henry nor Kevin were able to complete a category before or after intervention suggesting that they did not fully understand the task requirements. Bernard and Ruby scored at floor before and after intervention. As detailed in Table 37, only Alan's performance appears to have significantly improved after intervention. Before intervention, he could not complete a category but after intervention he was able to complete one, albeit taking 37 trials to do so. His overall total correct score increased from three before intervention to 28 after intervention. Whilst Henry's and Peter's total correct score changed after the intervention, it is possible to score some items correctly by chance on the WCST-64 (see Section 5.4.2). It is the ability to complete a category (or more than one category) that determines non-verbal reasoning and cognitive flexibility abilities, and neither Henry nor Peter managed this.

Table 37 Raw scores and results of statistical testing for non-verbal reasoning as measured by the WCST-64

Participant	Trials to complete first category B	Trials to complete first category P	Number of categories completed B	Number of categories completed P	Total correct n=64 B	Total correct n=64 P
Bernard	NC	NC	0	0	0	0
Peter	NC	NC	0	0	7	11
Alan	NC	37	0	1	3	28
Ruby	NC	NC	0	0	0	0
Henry	NC	NC	0	0	4	5
Kevin	NC	NC	0	0	0	0

B= baseline P= post intervention NC=not completed

6.2.4 Language

Results of a McNemar Test indicate a statistically significant difference in the proportion of correct responses before and after intervention on the AST (Whurr, 2011) for two participants (Bernard p=0.002 (two tailed), Peter p=0.004 (two tailed)). Inspection of their raw scores in Table 38 indicate that Bernard's score increased from 2 to 11, and Peter's from 0 to 9 from a possible 40. Alan, Henry and Kevin did not show a significant difference in the proportion of correct responses and Ruby scored at floor at baseline and post intervention.

Table 38 Raw scores and results of statistical testing for auditory comprehension as measured by the AST

Participant	B n=40	P n=40	McNemar p value (two tailed)
Bernard	2	11	**p=0.002***
Peter	0	9	**p=0.004***
Alan	12	11	p=1
Ruby	0	0	n/a
Henry	10	10	p=1
Kevin	4	3	p=1

B= baseline P= post intervention *indicates a statistically significant result

6.2.5 Mood

Three participants (Bernard, Peter and Henry) showed an improvement in mood after intervention. Table 39 details SoDS (Hammond et al., 2000) scores at baseline, post intervention and maintenance. At baseline, Bernard, Peter and Ruby were showing three or more low mood behaviours (out of a possible six). According to the test, a score of three or more is suggestive of a mood issue. Bernard's score reduced from 3 to 1 immediately after intervention, suggesting he no longer had a mood issue but increased to 2 at maintenance, demonstrating a deterioration (but not to baseline level). Peter's score reduced from 5 to 4 immediately after intervention. This improvement is still suggestive of a mood issue. However, at maintenance Peter's score reduced to 1 demonstrating a substantial improvement in mood. Ruby's score of 3 remained unchanged. She demonstrated a mood issue over the course of study. Alan and Kevin's mood scores stayed the same over the course of the study (1) and indicate they consistently did not have a mood issue.

Table 39 Mood screening scores as measured by SoDs

	SoDs Score (n=6)		
Participant	**B**	**P**	**M**
Bernard	**3***	1	2
Peter	**5***	**4***	1
Alan	0	0	0
Ruby	**3***	**3***	**3***
Henry	1	0	0
Kevin	1	1	1

B= baseline P= post intervention M=maintenance Score ≥ 3 indicates a mood issue (Hammond et al., 2000) and is indicated by *.

6.2.6 Summary of secondary outcome measures

The intervention was found to lead to statistically significant improvements in non-verbal visual semantics as measured by picture categorisation for four out of six participants, and non-verbal visual semantics as measured by gesture to picture matching for two participants. Visual perceptual skills as measured by object to picture matching was seen to improve for two participants and auditory semantics as measured by sound to picture matching was seen to improve for one participant.

Three participants (Henry, Bernard and Alan) showed gains on measures of attention, problem-solving and non-verbal reasoning. Henry made significant gains on the Flanker Task and RCPM. Bernard made significant gains on the BNVRT and RCPM. Alan was the only participant to show improvement on the WCST-64 after intervention. These results highlight that change was not consistent across the three assessments of non-verbal reasoning/problem solving.

Two participants (Bernard and Peter) showed significant improvements in auditory comprehension as a result of the intervention. Mood improved for Bernard and Peter over the course of the study but remained a persistent issue for Ruby.

The results highlight that Bernard made the most changes as a result of the intervention and that Henry showed the least change. Henry scored at ceiling on object to picture matching and picture categorisation across all testing points and did not make significant gains on gesture to picture matching or sound to picture matching tasks. Ruby made significant gains in two tasks but scored at floor across all testing points in seven of the nine directly assessed secondary outcome measures. Heterogeneity of the group is therefore evident. Within subject variability was also a notable issue with unstable baseline scores often observed.

6.2.7 Pilot outcome measure: INTERPReT

Inter- and intra-rater reliability data for the INTERPReT (Adjei-Nicol et al., n.d.) are shown in Table 40 and Table 41. A two-way random effects, single measure, absolute agreement intra class correlation (ICC) revealed good inter-rater reliability based on Cicchetti (1994), ICC(2,k) =0.869. A two-way mixed effects single rater absolute agreement ICC calculation was performed, and the result ICC (2,k)= 0.978 revealed excellent intra-rater reliability according to Cicchetti (1994).

Table 40 Data from the INTERPReT used for inter-rater reliability testing

Video	Rater 1 Score n=55	Rater 2 Score n=55
1	34	32
2	42	39
3	40	38
4	49	50
5	37	38
6	49	51

Table 41 Data from INTERPReT used for intra-rater reliability testing

Rater	First score n=55	Second score n=55
1	34	35
1	35	39
1	42	46
2	46	42
2	30	30
2	17	17

Table 42 details the results for each of the three scenarios and total score at baseline, post intervention and maintenance for each participant. Results indicate variability in performance across scenarios. At baseline no participant scored similarly on all three scenarios. After the intervention, all participants improved in score on at least one scenario, but none did so across all three scenarios, and most did not maintain gains by the time of follow up testing. Information on the scoring can be found in Table 19 (p. 101). Individual participant scores for the 11 behaviours rated within each scenario can be found in Appendix 17.

Table 42 Raw INTERPReT scores for each participant a baseline, post intervention and maintenance.

Participant	Scenario 1 n=55			Scenario 2 n=55			Scenario 3 n=55			Total score n=165		
	B	P	M	B	P	M	B	P	M	B	P	M
Bernard	46	42	54	45	43	33	30	35	42	121	120	129
Peter	45	49	45	40	47	40	28	39	27	113	135	112
Alan	54	49	55	49	54	55	39	45	44	142	148	154
Ruby	28	31	10	17	9	8	26	16	8	71	56	26
Henry	52	55	53	49	55	54	55	55	55	156	165	162
Kevin	42	50	28	34	34	40	37	36	50	113	120	118

B=baseline P=post intervention M=maintenance

Using the MCID calculation (Section 5.5), an improvement of 5.5 points or more on any one scenario, or an improvement of 16.5 points or more in total INTERPReT score constitutes clinical significance. On scenario 1 only Kevin made clinically significant gains after the intervention, with his score increasing by 8 points, from 42 to 50 out of 55. However, by the time of maintenance testing, Kevin scored 28/55, lower than at baseline. Immediately after intervention Peter improved by 4 points to 49/55 and Ruby by 3 points to 31/55 but neither participant maintained these small gains, with Ruby performing significantly lower at maintenance (10/55) than at baseline. After intervention Henry's score increased by 3 points to 55, reaching ceiling, then reduced to 53 at maintenance. Bernard and Alan's performances deteriorated from 46 to 42 out of 55, and 54 to 49 out of 55, respectively, but were near or at ceiling at maintenance (54 and 55, respectively).

On scenario 2, Peter, Alan and Henry made clinically significant gains post intervention. Peter's score improved by 7 points from 40 to 47, Alan and Henry's scores by 6 points from 49 to 54 and 49 to 55 respectively. Only Alan and Henry showed maintenance of gains made. Alan's score increased from 54 to 55 at maintenance and Henry's reduced slightly from 55 to 54. Peter's score at maintenance however reduced back to baseline level (40). Bernard and Ruby scored lower after the intervention than at baseline on this scenario. Bernard's score deteriorated from 45 to 43 and Ruby's score reduced from 17 to 9. At maintenance Bernard's score reduced further to 33 and Ruby's reduced by one point to 8. Kevin's score stayed the same immediately after intervention at 34 but increased by six points to 40 at maintenance.

On scenario 3, Bernard, Peter and Alan's performances improved immediately after the intervention, but only Peter and Alan showed clinically significant gains. Bernard's score increased from 30 to 35. However, Peter's score increased by 11 points from 28 to 39 and Alan's score increased by 6 points from 39 to 45. Bernard's performance on this scenario further improved by seven points at maintenance to 42 which is a clinically significant change. Alan maintained the majority of his gains, with his score deteriorating by only one point to 44 at maintenance. Peter's performance at maintenance however had deteriorated from 39 to 27, close to baseline levels. Henry scored at ceiling (55) across testing points on this scenario. Ruby's score deteriorated over the study, her score reduced from 26/55 at baseline to 16/55 after intervention and 8/55 at maintenance.

Analysis of total scores (see Table 42) indicates only Peter's total score improved by a sufficient amount after intervention to constitute clinical significance(>16.5). His total score increased by 22 points, from 113/165 to 135/165 and a Wilcoxon signed-ranks test showed a statistically significant median increase ($z=-1.897$ $p=0.03$, one tailed). However, by maintenance testing Peter's score reduced to baseline levels (112/165) and a statistically significant median increase was not noted when baseline and maintenance performances were compared ($z=-1.36$ $p=0.446$, one tailed).

Although Alan and Henry's total score improvements were not found to be clinically significant immediately after intervention, statistically significant median increases were noted (Alan z=-2.226 p=0.013, one tailed; Henry z=-1.841 p=0.033, one tailed). Comparison of baseline and maintenance performances also indicated statistically significant median increases for these two participants (Alan z=-2.354 p=0.008, one tailed; Henry z=-1.857 p=0.031, one tailed).

Bernard's overall score marginally reduced after intervention from 121 to 120 (z=-0.254 p=0.399, one tailed). At maintenance Bernard's total score increased to 129, but a statistically significant median increase was not observed. (z=-0.535 p=0.297, one tailed). Kevin's overall score increased from 113 to 120 immediately after intervention, but this was not clinically significant and neither was a statistically significant median increase noted (z=-3.51 p=0.34, one tailed). At maintenance Kevin's score reduced to 11. Although this was above the baseline level, a statistically significant median increase was not observed when performance at maintenance was compared with baseline (z=-0.552 p=0.291, one tailed).

Ruby's total score deteriorated from 71 to 56 immediately after intervention, however a statistically significant median reduction was not observed (z=-1.496 p=0.068, one tailed). At maintenance testing Ruby's total score further reduced to 26 and when compared to baseline performance a statistically significant median reduction was noted (z=-2.4333 p=0.0075, one tailed).

In summary, functional communication as measured directly using the INTERPReT, was seen to differ across different scenarios. When overall performance was evaluated, three participants made statistically significant gains after intervention but only one participant made improvements deemed clinically significant. The merits of this pilot outcome measure will be discussed in Chapter 7.

6.2.8 Control task, spoken word repetition

Three participants (Bernard, Peter and Ruby) were unable to perform this task on all testing occasions. Those that did (Alan, Henry and Kevin) showed some baseline instability but scores were consistent on the second and third attempts at the task. For these participants, WEST-ROC was used to determine whether there was a significant difference in the amount of change during baseline testing compared to after intervention. Results are shown in Table 43. For Alan and Henry there was not a significant difference in the amount of change at baseline and after intervention but for Kevin, there is a statistically significant difference (t(15)=3.36, p=0.008 (two tailed)). Table 43 shows he scored 7/16, 3/16 and 3/16 at baseline and 8/16 post intervention and at maintenance. This suggests the amount of change in single word repetition was greater after intervention than at baseline and that this skill improved after the intervention. This means Kevin's improvements on primary or secondary outcome measures cannot be relied on to show change as a result of the intervention and should be treated with caution.

Table 43 Raw scores and results of statistical testing for spoken word repetition as measured by the CAT

	B1 n=32	B2 n=32	B3 n=32	P n=32	M n=32	Statistic	t	p value (two tailed)
Bernard	0	0	0	0	0	n/a/	n/a	n/a
Peter	0	0	0	0	0	n/a/	n/a	n/a
Alan	2	4	4	4	4	WEST-ROC	0.696 df (15)	p=0.994
Ruby	0	0	0	0	0	n/a/	n/a	n/a
Henry	5	7	7	4	5	WEST-ROC	-1.809 df(15)	p=0.182
Kevin	7	3	3	8	8	WEST-ROC	3.36 df(15)	**p=0.008***

B=baseline, P=post intervention M=maintenance *=statistically significant result

6.3 Participants' performance during the intervention

Performance during and progress through the intervention varied across individual participants. An attempt was made to ascertain whether there were any patterns in performance within or between participants.

Firstly, participants were grouped according to whether they made clinically significant gains on all, some or none of the three functional communication outcome measures (overall CI and QC as measured by the ASHA-FACS, and one or more INTERPReT scenario). Table 44 shows that Alan, Henry and Kevin made clinically significant gains in all three outcome measures. Bernard made clinically significant gains on ASHA-FACS QC and CI, but not on any INTEPReT scenarios. Peter made clinically significant gains on ASHA-FACS CI and two INTERPReT scenarios but not QC. Ruby made no functional communication gains. Task performance within these three groups of participants was compared based on the number of intervention tasks each participant "passed" that is, the number of tasks on which they met the success criterion (see Section 4.4, p.92 and Appendix 3). Table 44 highlights that Alan and Henry made functional gains in all three functional communication outcome measures and met success criterion on 15/16 (94%) and 16/16 (100%) of tasks respectively. Bernard and Peter made functional gains on two functional outcome measures and met success criterion on 14/16(88%) and 12/16 (75%) tasks respectively. Ruby did not complete the intervention, met success criterion on only 3/12 (25%) tasks, and did not make any functional gains. An outlier is Kevin who made gains in all functional communication measures but met the success criterion on only 6/16 (38%) tasks. These six tasks were: visual scanning, shift gaze with no competition, object matching, match two connected pictures, sound to picture matching and complete the category. This could suggest these six tasks are particularly important. However, as described in section 6.2.78 Kevin's performance on the control task improved. It is therefore not possible to ascertain whether his positive functional communication changes are the result of the intervention or whether there was an unknown factor that influenced his performance on the control task.

An attempt was made to order the intervention tasks hierarchically in terms of level of complexity but this was a challenge as there are gaps in knowledge about current models of cognition (see discussion in Section 4.2, p.83). Table 44 also shows that it was possible to fail tasks earlier in the programme but pass later tasks reliant on these skills. One example is Bernard who failed to meet success criterion on the "shift gaze with competition" task but could complete matching two connected pictures and odd one out which would require ability to shift gaze whilst competing targets are still present. Another example is Kevin who failed to meet success criterion on the auditory sustained attention task but did do so on sound to picture matching. This finding suggests tasks in this novel intervention may not be ordered by level of difficulty as intended. This provides interesting insights into cognitive processes that will be discussed in the next chapter.

Table 44 Summary of participants' performance in all tasks in the intervention and on functional communication outcome measures

pt	Visual scan	Shift gaze no comp	Shift gaze with comp	Visual sust. atten^n	Auditory sust atten^n	Object Match	Visual selective atten^n	Object to picture match	Gesture to picture match	Match 2 connected pictures	Picture cat^n	Sound to picture match	Odd one out	Complete category	Choose & collect similar	Choose & collect cat
A	√	√	√	√	√	√	√	√	√	√	* √	√	√	√	√	X (80)
H	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
B	√	√	X (80)	√	√	√	√	√	* √	√	* √	√	√	√	√	X (80)
P	√	√	X (80)	√	√	√	√	√	* √	√	* √	* √	X (70)	√	X (70)	X (60)
R	√	√	X (80)	X (60)	X (60)	√	X (10)	X (10)	X (25)	X (0)	* X (40)	X (0)	NC	NC	NC	NC
K	√	√	X (60)	X (40)	X (40)	√	X (30)	* X (50)	* X (60)	√	* X (80)	√	X (40)	√	X (50)	X (60)

A= Alan, H= Henry, B=Bernard, P=Peter, R=Ruby, K=Kevin Picture sust= sustained atten^n=attention match=matching cat^n = picture categorisation cat=category

Participants shaded this colour made clinically significant gains in all functional communication outcome measures.

Participants shaded this colour made clinically significant gains in two functional communication outcome measures only.

√ indicates participant reached 90% success criterion on task

x indicates participant never reached 90% success criterion on this task. Their highest % score is denoted in brackets.

NC= not completed * indicates a statistically significant change in performance was found on this task

6.4 Summary of results

The intervention led to improvement in functional communication for all but one participant. This was most notably demonstrated by the changing level of assistance and support required to communicate basic needs. Positive outcomes were also seen but to a lesser degree in adequacy, appropriateness and promptness of communication, social communication and the judged level of communication burden carried by a communication partner. Non-verbal semantic skills as measured by gesture to picture matching improved for two participants with generalisation to untreated items occurring. Non-verbal semantic skills as measured by picture categorisation significantly improved for four participants with generalisation to untreated items occurring for three of the four participants. Specific individuals also made gains in selective attention, problem solving, mood and auditory comprehension. A strong finding was that assessment used appeared to influence results. Functional communication improvements were observed in more participants when measured using the ASHA-FACS than the INTERPReT. In addition, performance differed across different assessments of similar skills (for example, non-verbal reasoning and problem solving). Findings from the spoken word repetition control task, present an issue for overall interpretation of findings because one participant showed statistically significant improvement in repetition after intervention and three were unable to perform the task at all. These and other findings will be explored and discussed in the following chapter.

7 Discussion

This thesis has investigated the effect of a novel non-linguistic cognitive intervention on the functional communication, cognition and language skills of six PwGA. The primary aim was to assess whether the intervention would lead to improvement in functional communication and whether these improvements would be maintained. A further aim was to measure any changes in non-verbal cognition, auditory comprehension and mood. Chapters 1 and 2 reviewed literature on global aphasia, the relationship between aphasia and cognition and cognitive interventions in aphasia. Chapter 3 described a survey investigating UK SLT clinical practice for global aphasia. The development of a novel non-linguistic cognitive intervention and of an observational functional communication measure suitable for global aphasia (the INTERPReT, Adjei-Nicol et al., n.d.) was presented in Chapter 4. Chapter 5 detailed the intervention study methodology, and results were presented in Chapter 6.

This chapter will first provide a summary of the main findings in Section 7.1. Then, Section 7.2 will discuss how the study informs knowledge on global aphasia and response to treatment. Following this, Section 7.3 discusses the relationship between cognition and aphasia. Section 7.4 details the implications of findings for assessment in global aphasia and in Section 7.4.1 the INTERPReT (Adjei-Nicol et al., n.d.) is evaluated. Section 7.5 explores implementation issues and recommendations for future research. A summary of study limitations is presented in Section 7.6 and finally, the chapter ends with conclusions in Section 7.7.

7.1 Main study findings

The primary purpose of this case series multiple baseline ABA design intervention study was to determine the effect of a novel non-linguistic cognitive intervention on the functional communication of PwGA. Participants received the intervention programme consisting of 16 tasks three times a week for up to 6 weeks. Five of the six participants completed it in less than 6 weeks (average 3 weeks). The ASHA-FACS (Frattali et al., 1995), a proxy report tool, revealed clinically significant improvements in overall CI for five of six participants and statistically significant improvements for four participants. The ASHA-FACS further revealed clinically significant improvements in overall QC for four of six participants and statistically significant improvements for three participants. Clinically significant improvements were highest in the domain of communication of basic needs, with five participants increasing in at least one descriptive category level. Functional communication as measured using the INTERPReT (Adjei-Nicol et al., n.d.), a novel observational measure, revealed statistically significant improvements after intervention for three participants but clinically significant improvement for only one participant. The improvements observed after intervention were made after an average of nine sessions of therapy (range five-15) and on the ASHA-FACS maintenance of gains at 3-months were also observed. The findings demonstrate that these PwGA were able to participate in this cognitive treatment and make functional communication gains after receiving a dose compatible with clinical practice in the UK. Prior to this study, reported improvements for PwGA suggested the need for intensive (daily) or protracted (6 months or longer) doses of intervention (see for example Samples & Lane, 1980; Sarno & Levita, 1981; Helm-Estabrooks et al., 1982; Denes et al., 1996; Basso, 2010; Smania et al., 2010; Morrow-Odom & Swann, 2013) and maintenance of gains after the cessation of treatment were rarely reported.

All six participants made statistically significant improvements in at least one cognitive area after the intervention. In this study, visual semantic skills appeared the most receptive to change after intervention, with five of the six participants making improvements in either gesture to picture matching, picture categorisation or both. The intervention indirectly improved auditory comprehension and mood for two participants. The results of this study suggest new insights into the condition of global aphasia and provide some evidence to support a critical link between cognition and functional communication in aphasia. Such information is relevant to clinicians working with global aphasia and aphasia researchers. However, the findings highlight the gaps in current knowledge about the mechanism by which cognition links to aphasia and supports functional communication. These issues will be discussed in the following sections.

7.2 Global aphasia and response to treatment

Historic beliefs and assumptions have been that PwGA do not benefit from intervention, lose any gains made after intervention ceases, and rarely make functional communication gains (see for example Schuell et al., 1964; Marshall, 1987b, 1987a; Peach, 2001). The findings of this study suggest that this is not always the case, showing that PwGA can make clinically significant cognitive and functional communication improvements after intervention and maintain these for 3 months. Marshall (1987b, 1987a) argued that due to the limited gains PwGA often make, SLT resources should not be directed to those with the condition and instead should focus on those with milder deficits. However, authors such as Edelman (1987) and more recently Salis & Edwards (2015) have promoted the provision of intervention to PwGA, and results from the survey in Chapter 3 suggest that this is happening in clinical practice in the UK. Nevertheless, very few studies have been able to provide evidence to show functional communication gains being made after intervention with this population. Interestingly, clinicians in the survey reported that a lack of motivation and participation contributed to limited outcomes. In this study, all six participants either completed the full intervention programme or the maximum number of sessions and there were no drop-outs. This suggests the intervention was acceptable to the participants and that some with the condition have the ability to be motivated, consistently engage and participate when intervention tasks are set at an appropriate level. Participants made gains despite being on average 2.5 years post onset. This supports findings from authors such as Samples & Lane (1980) and Smania et al. (2010) that the trajectory for recovery in global aphasia may be longer than traditionally expected. This has implications for clinical practice in the UK. Survey findings highlighted that approximately 70% of services surveyed do not provide intervention beyond 1 year post stroke. This may in part be due to the limited evidence base demonstrating positive outcomes after SLT in global aphasia but could also be due to service capacity and funding. In the UK, national clinical guidelines for stroke (Royal College of Physicians Intercollegiate Stroke Working Party, 2016) recommend intervention for aphasia secondary to stroke is provided for the first 4 months and that after this timeframe, intervention should be aimed at increasing participation in social activities using volunteers, assistants and family. This recommendation is based on evidence from randomised control trials that have grouped varying aphasia types and severities together. The guidelines do not discuss global aphasia specifically or how the provision of intervention may need to differ for different forms of aphasia. The current study provides evidence to suggest the need for additional research to add to the evidence base so that future guidelines can make specific SLT recommendations for global aphasia.

The review in Chapter 2 highlighted that there have been very few descriptions of global aphasia in the literature. It is widely accepted that those with the condition have impairments across all language domains, but descriptions of additional cognitive impairments have been sparse. Collins (1986), Garrett & Beukelman (1998) and Lasker & Garrett (2006) have theorised about the presence of additional deficits in areas such as visual non-verbal problem-solving and initiation but these authors have not provided evidence to support their claims. A study by Van Mourik et al. (1992) yielded some empirical evidence. They found that of their 17 participants with global aphasia, five could not complete the RCPM (Raven, 1956), four had difficulties with a cancellation task and three had difficulties with visual recognition. Their findings suggest the presence of additional deficits in reasoning, attention and memory. The present study adds to growing evidence of the presence of severe cognitive deficits across a range of domains in global aphasia. All six participants had difficulties completing the PPT (Howard & Patterson, 1992), WCST-64 (Kongs et al., 2000), Flanker Task (Eriksen, & Eriksen, 1974), BNVRT (Butt & Bucks, 2004) and RCPM (Raven et al., 1990) at baseline, with scores on these assessments frequently at floor or below chance. This suggests significant impairments in semantics, executive functioning, selective attention, visual non-verbal reasoning and problem-solving. Furthermore, in the present study, five of the six participants made errors at baseline testing on object to picture matching, suggesting significant visual perceptual deficits or difficulties understanding requirements for a basic matching task.

In the literature PwGA have on the one hand often been described as a homogenous group, unable to benefit from SLT, and on the other hand as heterogeneous group with differing cognitive and functional communication abilities. Van Mourik et al. (1992) suggested based on their findings, that PwGA fall into three groups. The first group are reported to have intact basic cognitive functions and the ability to learn compensatory strategies. A second group is described as displaying variable patterns of cognitive deficits that require training prior to any treatment. A third group is described as unmotivated with little communicative intent and limited functional communication (for example cannot draw, point with intent or use yes or no consistently). This last group are thought to be unable to benefit from direct SLT and the authors recommend that intervention should instead focus on communication partners. The findings in the present study support those of Van Mourik et al. (1992) to an extent. Firstly, they suggest that heterogeneity amongst those with global aphasia exists, because baseline profiles and response to intervention differed amongst participants. One participant (Ruby) is a clear outlier, failing to complete the intervention within the 6 week (18 session) timeframe and failing to make any functional gains after intervention. Findings also suggest that providing treatment for underlying cognitive impairments as proposed by Van Mourik et al. (1992) for their second group, can be beneficial. Specifically, this study has found that treatment of cognition can support functional communication gains. However, in contrast to the conclusions of Van Mourik et al. (1992), all participants in the present study were able to demonstrate a benefit from receiving direct one to one intervention. Even Ruby, despite no functional communication gains improved in visual perception and semantics. This study provides preliminary evidence to suggest that there is potential for PwGA with a range of profiles to benefit from intervention targeting underlying cognitive deficits. The findings do however raise questions about the reasons for differing functional outcomes and whether it is possible to predict which PwGA are likely to make functional gains after this intervention. Firm conclusions are impossible given the sample size however, initial hypotheses will be explored.

One explanation for different functional outcomes could be initial aphasia severity. Ruby was the only participant to show no functional communication gains after intervention and her baseline WAB-R (Kertesz, 2006) bedside screening performance, indicates she had the most severe linguistic impairments of all participants, scoring at floor on all sub-tests. Mark et al. (1992) concluded from their study of 13 PwGA that initial aphasia severity is the best predictor of recovery in global aphasia. The present study findings suggest it could also predict positive functional outcome after this intervention. Another explanation could be baseline mood. Ruby demonstrated five low mood behaviours at baseline on the SoDS (Hammond et al., 2000). A score of three or more is suggestive of a low mood issue. Interestingly, Bernard and Peter who made functional communication gains on only two functional communication measures after intervention also demonstrated three low mood behaviours at baseline. In contrast, Alan, Henry and Kevin who made gains on all functional communication measures did not demonstrate low mood at baseline. This provides anecdotal support for a link between low mood and poorer functional outcomes as suggested by authors such as Eriksson et al. (2008).

A further explanation for the differing functional outcomes amongst participants could lie in performance on the intervention itself. Ruby failed to achieve the 90% success criterion in 75% (9/12) of the tasks she completed, and also failed to complete the full intervention programme within the 6 week timeframe. This could suggest that programme completion and/or reaching the success criterion on a certain number of tasks is necessary for functional communication gains to be made. A larger sample size and robust testing of this hypothesis by either extending the duration of the intervention or ensuring the success criterion is reached before progression, is required to understand this further. Interestingly, the adaptation of the protocol after the pilot (discussed in Section 4.4, p.93) yielded little difference in performance. When participants failed a task, increasing the number of opportunities to practice the task from three to five did not lead to increased success. They continued to fail on attempts four and five. However, a limitation of the intervention protocol is that it did not examine the nature of errors. Instead, responses were scored as correct or incorrect only. It is possible that with the increasing attempts at tasks, the nature of errors changed. This could indicate improvement in a skill. For example, initially a participant could have made unrelated errors, but with further attempts may have begun to make semantically related errors. This would demonstrate some improvement in semantics, but the change would not be captured in the current scoring system. Future adaptations of the protocol could consider altering the scoring system, examining error patterns or ensuring success on each task before progression to the next.

Consideration of the pattern of performance for Alan, Henry and Kevin provides further clues as to which PwGA are more likely to benefit from this intervention. Alan and Henry made clinically and statistically significant gains in CI, QC and one INTERPReT scenario. Kevin made clinically and statistically significant gain in CI and QC but only clinically significant gains on one INTERPReT scenario. It is particularly interesting that Kevin made such substantial functional communication gains. His overall performance within the intervention is low. He reached the 90% success criterion on only 6/16 tasks, scoring between 30% and 80% (below the 90% criterion) on all other tasks. Despite this, he made sizeable functional gains which were comparable to Henry who reached the 90% criterion on all tasks and Alan who reached criterion on 15/16 tasks. Comparison of the performance of Alan, Henry and Kevin within the intervention (see Table 44, p. 149) highlights that they all met the 90% success criterion in the same six tasks: visual scanning, gaze shift without competition, object matching, matching two connected pictures and sound to picture matching. This may indicate that success on these particular tasks and acquisition of the skills they target (visual attention, visual perception, visual semantics and auditory semantics) may be most relevant to basic functional communication. Possibly there is some redundancy within the intervention or only a partial improvement or ability to perform a task is required to facilitate change. The small sample size and the fact Kevin (the pilot participant) did not receive the same protocol as the other five participants in the study somewhat complicates interpretation of findings. Further research is required to fully understand the importance of these five tasks and whether the intervention programme could be shortened.

In summary, findings from this study provide evidence that some PwGA can respond to and benefit from a cognitive treatment approach. However, not all participants made the same gains, demonstrating the heterogeneity of this client group and the need for future research to explore factors that influence outcome. The results provide evidence to support existing hypotheses about the importance of treating cognition for functional communication gains. Six specific tasks within this novel programme may be a factor in positive functional communication outcomes. However, further research is required to determine the key ingredients of the intervention and the underlying mechanism of changes. These issues will be further explored in the following section.

7.3 Cognition and aphasia

The evidence from existing literature suggests that spared cognition, especially executive function, improves functional communication outcomes. However, the link with cognition has mostly been explored in milder forms of aphasia, and functional communication has been considered only in terms of ability to switch to alternative means of communication (see for example Ward-Lonergan & Nicholas, 1995; Wallace et al., 2014; Purdy & Wallace 2016). The findings from the present study provides some specific knowledge to aid understanding on the importance of cognition for basic functional communication (such as communication of basic needs) in global aphasia. All participants had severe cognitive deficits at baseline across a variety of domains including executive functioning. Yet, five of the six participants made demonstrable functional gains. This suggests that contrary to previous findings cited above, having spared cognitive skills is not essential for functional communication improvements to be made in some with global aphasia. This is relevant to clinical practice because the survey found that in some services, PwGA are considered for one to one intervention based on whether they have the underlying cognitive skills to participate. The study findings here suggest cognitive deficits should not prevent intervention being offered. In contrast they indicate it might be possible for abilities in these underlying skills to be enhanced through treatment. Further research is warranted to confirm results of this small pilot study. In addition, future studies may wish to explore whether provision of this non-linguistic cognitive intervention prior to traditional SLT is beneficial in global aphasia.

The present intervention study was based on the premise that cognition is linked to functional communication and that treating cognitive deficits may improve functional communication. No study to date has included PwGA when exploring treating cognition for functional communication. The quality of evidence in studies of other aphasias is limited due to small sample sizes and methodological flaws such as the lack of a control measure. For example, in single case studies, Hardin & Ramsberger (2004) reported significant improvements in the ability to convey the main ideas in a supported conversation after providing PSSCogRehab (Bracy, 1994) in fluent aphasia, and Purdy & Van Dyke (2011) found that MCT (a treatment focusing on cognitive flexibility) improved functional communication as measured by CADL-2 (Holland et al., 1999) in Broca's aphasia. The mechanism by which cognition may support functional communication in areas other than modality switching has not been addressed. An attempt to explore the mechanism for change in the context of this study's findings suggests gaps in existing cognitive theory that will now be discussed.

Cognitive theories often reference a hierarchy, with attention deemed the most basic cognitive function and executive function the most advanced. Each cognitive domain has been investigated separately and the relationship between domains is not fully understood. The model of attention which has influenced many cognitive treatments in acquired neurological conditions (such as Sohlberg & Mateer, 1987; Sohlberg et al., 2001; Helm-Estabrooks et al., 2000) is that of Sohlberg & Mateer (1987). The model describes attention as a multidimensional domain but does not explicitly refer to links between other domains of cognition. The intervention in the current study included tasks treating multiple domains of cognition including: visual perception, sustained and selective attention, visual and auditory semantics. Executive functioning in the form of non-verbal problem solving was also trained indirectly through the repeated need for participants to ascertain task requirements without direct verbal instructions. The intervention was seen to lead to improvements in visual perception, visual and auditory semantics, non-verbal reasoning, functional problem solving, functional communication and in two cases language. The findings therefore support the existence of an interactive model of cognition involving attention, semantics and visual perception akin to the model proposed by Posner & Petersen (1990) (which suggested links between attention, executive functions and semantics), and consistent with evidence from imaging studies that cognitive processes may involve a large network of brain regions (Duncan, 2010; Mineroff et al., 2018). The findings from this current study suggest that for functional communication gains to occur, a range of cognitive process including attention, semantics and visual perception may have to be targeted.

Given the lack of an integrated model of cognitive domains, this novel cognitive intervention was designed with a hierarchical order of complexity based on Sohlberg & Mateer's (1987) model of attention and Warren's (1993) model of visual processing. However, results show that there were occasions when participants were able to complete tasks later in the intervention programme despite not successfully completing earlier tasks. For example, Bernard failed to meet success criterion on the "shift gaze with competition" task but could complete matching two connected pictures and odd one out which would require the ability to shift gaze whilst competing targets are present. This could suggest that some PwGA heavily rely on semantic processing and pre-morbid conceptual knowledge to complete tasks, so that when semantic processing is not required (as in the case of some earlier tasks within this intervention), tasks are more difficult for them. This shares similarities with the finding of Murray et al. (2006) who trialled a cognitive treatment called APT-II (Sohlberg et al., 2001) with a client with mild TBI and found that the intervention's hierarchical organisation did not correspond with their participant's performance. They found that the participant did not reach accuracy criterion on the simplest task within the intervention but could complete tasks deemed more difficult. There is a clear need for future research to further explore the domains of cognition and how they are organised so that the patterns of performance in people with cognitive deficits can be understood. Replications of this current study with a larger sample size and future studies manipulating the order and number of tasks in the intervention programme may enhance this knowledge.

Aside from exploring the potential to improve functional communication in global aphasia by treating cognition, studies have also attempted to ascertain whether language skills can be improved. This is based on the hypothesis that attention difficulties account for some comprehension deficits in aphasia. Helm-Estabrooks et al. (1982) found that VAT which targets visual perception and non-verbal semantics in the form of gestural comprehension and production, led to improvements in auditory and reading comprehension on the PICA (Porch, 1967). The authors hypothesised that the indirect training of cognition in the form of general attention, visual spatial and visual search skills may have underpinned these linguistic improvements. In the current case series, generalisation to auditory comprehension occurred for only two of six participants, yet the intervention shares many similarities with VAT (Helm-Estabrooks et al.,1982), such as its non-linguistic nature and focus on visual perception and semantics. It may have yielded less substantive generalisation than VAT (Helm-Estabrooks et al.,1982) because participants had more severe impairments. For example, Helm-Estabrooks et al. (1982) only included participants who had adequate attention span, ability to use everyday gesture and some ability to perform nonverbal cognitive tasks of memory and visual perception. In the current study however, all participants had impairments in such skills at baseline.

The use of non-linguistic tasks and limited verbal language in this study reduced task demands for participants and allowed for focus on cognitive skills. However, it may be that including some meaningful use of language such as verbal instructions or naming items within the intervention would have led to enhanced functional communication changes or increased generalisation to verbal language. Indeed, the functional communication outcome measures used in this study were not wholly non-verbal. The ASHA-FACS (Frattali et al., 1995) requires the proxy to rate behaviours such as the ability to follow simple directions, and the INTERPReT (Adjei-Nicol et al., n.d.) measures skills such as ability to answer a yes/no question which is given verbally. Despite only limited generalisation to language, overall, the promising results of the current study provide support for the use of non-linguistic tasks and non-verbal sessions in global aphasia. It appears that doing so may support the ability to engage in intervention and improve cognitive and functional communication skills.

In summary, findings provide support for existing evidence that cognition is important for functional communication and that treating cognition can improve functional communication in global aphasia. Previous studies have focused on the relevance of attention and executive functioning to functional communication, but findings from this study highlight the importance of visual perceptual and semantic skills also. This study also provides support for the use of non-linguistic tasks and approaches to treat functional communication in this population.

7.4 Measuring change in global aphasia

The review in Chapter 2 highlighted that due to the high linguistic and cognitive demands of existing tools, it can be difficult to elicit information on residual skills or strengths in global aphasia. The lack of suitable assessments makes measuring any change in the client group a challenge and may have contributed to the limited gains often reported in research studies.

When assessing cognition in aphasia, assessments such as WCST (Grant & Berg, 1948) and RCPM (Raven, 1956) have frequently been used due to their limited demands on expressive language. Chapter 2 discussed how the receptive language and underlying cognitive skills required to complete such assessments have rarely been considered, yet they may be the reason for failing. In this study, all participants had significant difficulties completing the shorter WCST-64 (Kongs et al., 2000) which itself has been found to be difficult for some people with milder forms of aphasia to complete (see Fridriksson et al., 2006). The patterns displayed on the WCST-64 by participants in the current study suggest there may be issues understanding the instructions and requirements. However, visual perceptual deficits, problem-solving and cognitive flexibility may also be contributing to a poor performance. Similarly, some participants scored low on the RCPM (Raven et al., 1990), Flanker Task (Eriksen & Eriksen, 1974) and BNVRT (Butt & Bucks, 2004) both before and after intervention. It is therefore impossible to unpick whether impairments in the target domain (selective attention and non-verbal reasoning respectively), caused this poor performance or deficits in comprehension, visual perception, or semantics also contributed. Nevertheless, the fact that two or three participants in the present study were able to complete the RCPM, Flanker Task and BNVRT at baseline and/or make significant improvements on them after intervention, suggests that these cognitive assessments can be useful in global aphasia. In particular, this study highlights the potential benefit of the BNVRT for assessing real-life problem solving without high linguistic demands. This assessment, whilst used clinically is not commonly used in research.

The inclusion of informal basic visual perceptual and semantic tasks as outcome measures in the current study, provided additional information on cognitive changes that may not have been apparent had only published tools been used. The intervention led to significant improvements in object to picture matching and picture categorisation with all participants even Ruby (who demonstrated the most severe deficits at baseline). This highlights the need for researchers to consider the face validity of existing cognitive measures and to include tasks measuring basic non-verbal cognition when working with PwGA.

Few intervention studies that have measured functional communication in global aphasia have used standardised tests. For example Ramsberger (2005), Ho et al. (2005) and Basso (2010) provided only anecdotal reports of functional communication gains or used informal tools to analyse conversation. However, Morrow-Odom & Swann (2013) reported improvements in communication independence on the ASHA-FACS (Frattali et al., 1995) after using MIT and non-verbal cognitive tasks. Findings from the current study also indicate the ASHA-FACS is an appropriate measure of functional communication in global aphasia. The assessment was able to capture changes in low level functional communication behaviours such as understanding facial expressions, tone of voice and initiation of communication. Furthermore, this study shows the tool is also able to capture changes in qualitative communication such as how timely communication is and how much of a burden is placed on the communication partner. These additional features are particularly relevant in global aphasia, where due to the severity of language impairment, accuracy may not significantly change but areas such as speed of processing or reaction time may. Such changes have the potential to impact on communication partner burden, for example in terms of the number of times the communication partner needs to repeat a question or the duration of time the communication partner must wait for a response. Thus, the breadth of the scoring system used in the ASHA-FACS appears advantageous for global aphasia.

The gains observed on the ASHA-FACS in this study are promising. However, there is no consensus on how to measure clinically significant change and whether this is independent of statistical significance. Kiran & Thompson (2003) suggested a change in score of 5% was clinically significant in their study of the effect of a semantic feature treatment to improve naming in four participants with fluent aphasia. Others such as Howard et al. (2015) argue for a broader definition of clinical significance such as any change that makes a difference to a participant’s life. It can be useful for the purpose of research to have a quantified amount of change considered clinically significant that can be applied to all participants and to this end this study made use of a measure known as MCID. In comparison to the 5% standard used by Kiran & Thompson (2003), the MCID in the current study uses a higher threshold (10% of the total range of measurement) and appears a useful way to compare change in the absence of or alongside statistical significance. However, it has not previously been used in aphasia literature and has been more commonly used in post-stroke physiotherapy studies (see for example Van der Lee et al., 2001). More in depth analysis of this measure and its appropriateness for use in aphasia is required.

In this study, the ASHA-FACS was completed by a significant other and is consequently subject to bias. The relative/friend was aware of the purpose of the study and whether they were scoring abilities at baseline, post-intervention or maintenance. A further issue is that although the ASHA-FACS manual states the tool can be used with a significant other, all field testing and psychometric data is based on its use with a clinician as rater. Therefore, the validity and reliability of the tool as a measure of functional communication when completed by a relative or friend is unknown and is problematic for comprehensive analysis. The fact this tool was the only published one deemed capable of capturing functional communication changes in global aphasia, highlights the need for further consideration of this population when designing assessments. The issues with the ASHA-FACS were part of the rationale for also including an observational measure in the study. Findings from the use of this tool will be discussed in the following section.

In summary, this study has demonstrated that a small number of existing cognitive and functional communication assessments can capture changes global aphasia. However, careful consideration of underlying cognitive and linguistic demands is needed to interpret results. The ASHA-FACS shows promise as useful for global aphasia but has limitations because it is an indirect measure. Ideally its use should be combined with direct observational data.

7.4.1 A critical evaluation of the INTERPReT

The primary reason for designing the INTERPReT (Adjei-Nicol et al., n.d.) was that no existing direct assessment of functional communication appeared capable of capturing small changes in basic skills relevant in global aphasia (such as understanding facial expression, or using non-verbal communication to request help and make wants and needs known). It was deemed necessary to include a direct measure in this study to mitigate for the inherent bias involved in using a proxy to complete the ASHA-FACS. In contrast to many existing functional communication tools where the main focus has been measuring transactional language such as making requests, the aim of the INTERPReT was to also assess natural interaction and social communication skills. The advantage of the INTERPReT is its authenticity and its closeness to real life interaction. However, scenarios were simulated rather than real, and this may have influenced performance. There was limited information on which to base the tool as there has been little to no investigation as to what constitutes basic functional communication or interaction for PwGA. The researcher built the scenarios included in the tool around activities such as Connect 4™, jigsaw puzzles, playing cards and dominoes, which were reported by SaLTs in the survey to be used in clinical practice. However, there is no information as to how acceptable or accessible these tasks have been with this client group. In addition, whilst participants were given a choice of activity, no attempt was made to ascertain whether the options were familiar to a participant. Whilst the INTERPReT provides an opportunity to assess natural interaction, it is probable this will be compromised if the situation is unfamiliar. The present study was the first time the INTERPReT has been used to measure functional communication in global aphasia and the pilot findings highlight the need for more extensive testing of this tool. In particular there is need for a clearer understanding of how those with and without global aphasia respond when engaged in the chosen activities. This would enable the rating scale and predicted behaviours to be validated. A potential way to mitigate for the issues of unfamiliarity with the activities could be to observe or record real life communication interactions with relatives or friends and for these to be scored by an independent rater. The recording and rating of real-life conversations is used in approaches such as Better Conversations with Aphasia (Beeke et al., 2013) and could be adapted for use in global aphasia. However, there are issues of replicability arise with such an approach. Real life conversations vary in topic and the relative/friend may use strategies inconsistently across different conversations. An objective tool (akin to the INTERPReT) that could be used within real life interactions and conversations would be an ideal solution.

The ASHA-FACS captured clinically significant improvements after the intervention for five out of six participants. In contrast, the INTERPReT captured clinically significant improvements on a single scenario for three participants and clinically significant improvement overall for only one participant. The discrepant findings may be due to the fact the two assessments measure functional communication in different ways. The ASHA-FACS takes into consideration reported performance across a range of communication scenarios, providing an average score as to the person’s overall communication potential. The INTERPReT on the other hand is a direct measure and provides information on the persons communication performance at a specific point in time. It is well documented that PwA’s abilities fluctuate and impaired attention is frequently cited cause for this (see Villard & Kiran, 2018). In global aphasia where both linguistic and cognitive deficits are severe, this fluctuation may be more marked. Therefore, scoring functional communication based on small snap shots in time in this population may not provide a true reflection of their communicative potential and may risk under-estimating their abilities. In addition, during the INTERPReT the participant communicated with the researcher who was relatively unfamiliar to them, in comparison interactions with close relatives/friends were measured by the ASHA-FACS. Overall, the study findings appear to support the suggestion of Manochiopinig et al. (1992) that use of a proxy may be the optimum way of measuring functional communication in severe aphasias. However, the fact that clinically and statistically gains were found for some participants on the INTERPReT highlights some promise for this tool.

Another reason for the discrepant findings between the ASHA-FACS and INTERPReT may be the fact that the rating scale used for the INTERPReT focused on the accuracy of responses and the degree of prompting required to elicit them. Other changes such as in response time may have been present but not captured. Future adaptation of the tool could include assessment of response time or qualitative analysis of all observed communicative behaviours. Whilst a high level of agreement between and within two independent raters was found, we do not know whether it is a valid or reliable measure of functional communication. A next step would be to correlate results from the INTERPReT with a validated measure such as the ASHA-FACS (when rated by a SaLT).

The ability to successfully complete the INTERPReT requires verbal comprehension, selective attention and functional problem solving skills. Face validity is therefore an issue and further piloting and research is required to refine the tool and test its psychometrics. A further potential limitation is the length of the sample taken. The INTERPReT scenarios typically lasted 10-15 minutes. It is possible that this did not provide participants with sufficient time to be able to fully engage in the activity and demonstrate all their potential behaviours. Further research to explore whether longer sample length leads to increased number of elicited behaviours is warranted.

Three different scenarios were included in the INTERPReT to mitigate for learning effects and allow participants to display their abilities in a range of tasks. However, within-subject variability in performance was noted, whereby, participants demonstrated a behaviour in one scenario but not in another. An additional observation is that most participants scored highest at baseline on scenario 1. This could be due to fluctuations in performance, but an alternative explanation could be that activities and tasks in each scenario were not comparable, and that scenario 1 was in some way easier. Task demands and familiarity with content and items did differ across scenarios. For example, looking through a newspaper or magazine and hearing a knock at the door as in scenario 1 may be more familiar to a person with global aphasia than playing snap or dominoes and hearing an alarm clock sound (scenario 3). The underlying cognitive skills required to play snap or dominoes may also be more advanced than for recognising photos in a newspaper or magazine. Further research is required to examine and compare the task demands and skills required within each scenario. An alternative solution would be to re-consider whether there is a need for multiple scenarios, or whether the same activity could be tested multiple times at baseline, after intervention and at maintenance.

In summary, the INTERPReT provides a novel way for basic functional communication skills to be assessed directly in global aphasia. It has been piloted here and shown to be able to capture changes in some PwGA, however, further development and testing is required before it can be used more widely.

7.5 Implementation and future research

This study directly links to the priorities of clinicians working with PwGA. The survey discussed in Chapter 3 highlighted that key challenges to working with this population are a lack of appropriate resources, the low motivation of clients, and their cognitive deficits. This intervention was designed specifically for PwGA and has proven to be acceptable and motivating, evidenced by the lack of dropouts and the engagement of all participants in sessions and tasks. The research priorities put forward by clinicians in the survey included the need to evidence that PwGA can benefit from SLT, and to investigate underlying cognitive impairments. This study has positively addressed these two issues by demonstrating that some PwGA were able to make gains in cognition and functional communication after an intervention that targeted underlying cognitive skills. Furthermore, the positive results were achieved after an average of nine sessions. In contrast to the majority of other treatments that have reported positive outcomes in global aphasia, this dose would be deliverable within most UK clinical settings according to survey findings. However, the survey was conducted in 2013 and the impact of austerity and cuts to services in the NHS may mean that even this dose is no longer viable. The intervention in this study was found to be beneficial at an impairment level cognitively even to the most profoundly impaired participant who performed at floor on all tasks at baseline. This has implications for current clinical processes and decision making. For example, survey findings suggested that in some cases clinicians make the decision as to whether to provide an individual with one to one intervention based on whether they display pre-requisite cognitive skills such as attention and object matching. However, the intervention findings suggest that individuals who may display deficits in such skills have the potential to develop and improve after targeted intervention and therefore should be offered therapy. It is possible that after completing a cognitive based intervention such as that described in this study, PwGA are better able to participate in traditional SLT. Comparing response to traditional SLT before and after receiving this novel intervention is a potential area for future research.

Prior to being considered for clinical use, the intervention in its current form requires significantly more field testing. According to Medical Research Council guidelines by Craig et al. (2006) the intervention in this study is classified as complex. There are a number of components to the intervention (for example, non-verbal delivery, non-linguistic stimuli, 16 tasks), a number of skills targeted by the intervention and a number of possible outcomes. In such situations Craig et al. (2006) suggest that successful implementation first requires a fully powered empirical study with a large sample size and evaluation of the intervention in a range of settings. They recommend a randomised control study consisting of parallel groups with an experimental and control arm. Given the heterogeneity of those with global aphasia explicit inclusion criteria would need to be set around the presence of additional cognitive impairments in any future RCT. Furthermore, timescales for recruitment would need to be carefully considered in order to achieve sufficient numbers. In this current study, the inclusion criteria were broad in order to be consistent with how PwGA present in clinical settings and ensure findings are generalisable. For example, individuals with severe comprehension deficits and without capacity to consent were included, as well as those with co-existing diagnosis such as apraxia of speech. The target sample size of six was achieved, however this took 10 months, much more time than anticipated. Two potential participants were found to be too variable and unpredictable in their levels of alertness to be able to take part and a further one was medically unstable, suffering repeated chest infections. The severity of stroke that induces global aphasia means that there is greater likelihood of co-morbidities that may limit ability to participate in research. In this study, participants were recruited from long term private rehabilitation units and community SLT services, however they were often not receiving active SLT or had been discharged due to making limited gains. Recent General Data Protection Regulation governed by the Data Protection Act 2018 (2018) may make it more difficult to contact participants who have been discharged from services without explicit consent to be contacted for research purposes. Local policies will need to be considered and other options for recruitment explored such as advertising and recruiting through nursing homes, GP surgeries and stroke groups.

A multi-site trial would also require a range of clinicians with differing amounts of experience to deliver the intervention. Training would therefore need to be provided. A written manual has already been developed which could be made available for this, however it is likely that SaLTs would require direct training and practice in novel elements not frequently used in current practice, such as delivering sessions non-verbally. Currently treatment tasks are paper based or computerised for use on a laptop. While the everyday objects and pictures needed are likely to be readily available in most SLT departments, laptops may not be easy to source in the NHS and desktop computers would not be practical when most clients are seen in the community. Due to the increased use of tablets and applications in clinical practice, it would be beneficial for the tasks to be adapted into app form before the intervention is tested any further. To ensure the intervention is delivered as intended by clinicians across sites, a fidelity assessment would need to be designed. Hart (2009) defines fidelity assessment as involving independent rater evaluation of target behaviours or treatment contents (drawn from active ingredients identified in the underpinning intervention theory) specified in a treatment manual. Video observation and scoring by an independent assessor is the gold standard for assessing treatment fidelity and could be used for this purpose. Active ingredients to be measured could include ensuring no verbal instructions are provided, no verbal naming of items is carried out, and that the process of step up and step down of tasks in the intervention programme is followed in a consistent way.

The feasibility of implementing an intervention such as this in clinical practice will likely be influenced by historical and institutional practices. In the survey only two respondents reported currently using non-verbal interventions and only 66% of 45 SaLTs surveyed treat cognition. Of those that do, 80% do so jointly with another discipline such as OT or psychology colleagues, and some reported that they do not feel confident in their knowledge of or skills in working on cognition. These factors are likely to be barriers to the intervention being implemented. Cognition has historically had little focus in SLT training curricula. As more research demonstrates the importance of cognition for positive treatment outcomes in communication disorders, teaching and training in this area may need adapting in the future. Continuing professional development courses in assessing and treating cognition may also be a helpful consideration for SaLTs working with adults with acquired communication difficulties. OT and neuropsychology are often the lead providers of cognitive assessment and intervention in neuro-rehabilitation settings, yet their knowledge of language and communication intervention may be limited. There is a clear need to further explore current inter-disciplinary working practices between SLT, OT and psychology in aphasia. Through this, a better understanding can be gained of how expertise can be shared, who is best equipped to provide cognitive interventions in which circumstances and with what additional training. One of the first steps would be to ensure the current study findings are disseminated widely through SLT, OT and psychology literature as well as multi-disciplinary conferences. It may be that future research investigates whether this intervention can be delivered by another discipline such as OT for example or by a rehabilitation assistant. Ultimately, the benefit of dissemination and discussion of this study's findings will be to enhance inter-disciplinary working and the overall quality of intervention for PwGA. Future studies may also wish to explore the benefit of this intervention in other forms of aphasia.

In summary, the study findings suggest the intervention holds promise for use in clinical settings. However, due to the complexity of the intervention, further investigation is required to determine the key ingredients, what works and why. Future studies need to systematically investigate the active ingredients by manipulating components such as the number and hierarchical order of tasks in the intervention programme, scoring system and the use of spoken language within sessions.

7.6 Study limitations

This was an exploratory study of a novel intervention. The preliminary findings are promising but require cautious interpretation due to the small sample size and a follow up study with larger sample size is essential.

Cautious interpretation is also required due to issues with the control task. Ideally, a control task should be one which participants can complete but is not subject to change as a result of the intervention. Due to the breadth of deficits PwGA present with, finding a task that met these criteria was challenging and further compounded by the fact that the intervention targeted a range of areas with direct and indirect changes possible in many domains. Spoken word repetition, reading comprehension and writing were all considered as control tasks because these skills were not expected to change as a result of the intervention. Spoken word repetition was finally chosen because it had the lowest task demands of the three options. However, three participants had no verbal output and were unable to attempt the task, and one participant (Kevin) had variable speech output secondary to apraxia of speech and his repetition skills were found to have improved after the intervention. Without clear evidence that performance on a control task stayed the same, analysis of the impact of the intervention is difficult. It is unlikely that selecting one of the other tasks (reading comprehension or writing) would have eliminated the issues, and this demonstrates the challenge of completing research using single subject experimental design with this population. A randomised control study whereby an intervention group is compared with a control group is likely the best way to mitigate for this in a future study.

A further limitation is that a carer related outcome measure such as Carers COAST (Long et al., 2009) was not included. Given the burden severe communication deficits can place on significant others, it would be useful to understand whether the improvements noted in participants functional communication and cognition had any impact on their friend or relative’s quality of life.

7.7 Conclusion

This research has shown that a non-linguistic cognitive intervention delivered for up to six weeks has the potential to improve functional communication and non-verbal cognition in global aphasia. Promisingly, the findings suggest that this client group can make gains at a functional level and maintain these gains after intervention ceases.

This is important for clinical practice where PwGA have often been found to make limited functional gains. Assessment of functional communication in this population remains a challenge and a novel tool designed for this study was found to require further piloting and refinement prior to being able to robustly capture changes in this population. Replication of this study with a larger sample size is also warranted. Nevertheless, findings have promising implications and offer an encouraging narrative on prognosis in global aphasia.

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9 Appendices

9.1 Appendix 1 Survey

Current Speech and Language Therapy Practices for Clients with Global Aphasia

Thank you for taking the time to complete this survey.
The aim is to investigate current Speech and Language Therapy practice for clients with global aphasia (CwGA) so that these practices can be considered in the design and development of a new treatment programme for this client group.

Please be assured that survey participants cannot be identified and that survey results will be analysed anonymously. The anonymised results will be referred to in my doctorate project and may be presented at conferences verbally or in poster form in the future.

You only need to complete this survey if you have previously worked with or currently work with clients with global aphasia.
The survey should take 10 -15 minutes to complete.

Thank you

Sharon Adjei
Speech and Language Therapist and UCL Doctorate Student

Current Speech and Language Therapy Practices for Clients with Global Aphasia

1. Which clinical setting do you work in?

☐ Acute ☐ In-patient rehabilitation ☐ Community ☐ Out-patients ☐ Other - please specify [ ]

Next

2. In which Borough or County do you work?

[ ]

3. How many years experience do you have as an SLT?

- 0 - 2
- 3 - 5
- 6 - 10
- 11 or more years

4. What is your current Banding?

- Band 5
- Band 6
- Band 7
- Band 8
- Other - please specify

5. In your current clinical setting, approximately how many Clients with Global Aphasia (CwGA) would you estimate you see in a year?

- 0 - 5
- 6 -15
- 16 - 30
- 31 - 50
- More than 50

Next

6. How would you define global aphasia?

7. In your opinion does global aphasia differ from severe aphasia?

YES NO

Next

8. If you believe global aphasia and severe aphasia differ, please specify how below

Next

ASSESSMENT

The following questions all relate to the assessment of CwGA.

9. How do you assess CwGA?

- [ ] Informal non-standardised language assessment
- [ ] Standardised language assessment
- [ ] Informal functional assessment
- [ ] Standardised Functional assessments
- [ ] Other - please specify

Next

10. Do you ever use the scores from standardised assessments to formally classify clients as having global aphasia?

- YES
- NO

11. Do you as a Speech and Language Therapist ever assess cognition in CwGA?

- YES
- NO

Next

12. If you assess cognition which cognitive parameters do you assess?

- attention / concentration
- memory
- visual processing
- planning
- organising
- self monitoring /self regulation
- other - please specify

13. If you as a Speech and Language Therapist assess cognition, how do you do so?

- informal assessment
- formal cognitive screen
- standardised cognitive assessment
- other - please specify

Next

TREATMENT

The following questions all relate to the treatment of CwGA

14. What type of treatment does your current service offer to CwGA?

- ☐ 1:1
- ☐ Group
- ☐ Both 1:1 and Group
- ☐ None- My service does not offer treatment to CwGA
- ☐ Other - please specify [ ]

Next

15. If you offer 1:1 treatment to CwGA , how do you decide which clients are appropriate to receive it? Please tick all that apply

- ☐ All CwGA are offered 1:1 treatment
- ☐ It depends on the amount of treatment the client has already had
- ☐ It depends on the client's response to treatment they have already had
- ☐ It depends on the setting / social situation the client is in
- ☐ It depends on whether the client has the necessary pre-requisite skills to participate in and respond to treatment
- ☐ It depends on whether my service has sufficient capacity to see CwGA. They are not always apriority.
- ☐ Other - please specify [ ]

16. How long post onset are the CwGA you treat in your current service? Tick all that apply

- ☐ 0-4 weeks
- ☐ 5-12 weeks
- ☐ 4-6 months
- ☐ 7-12 months
- ☐ 1-5 years
- ☐ Over 5 years

17. On average how long is each treatment session you offer to CwGA?
Please give your answer in minutes

[ ]

18. In a typical case approximately how often are you able to see CwGA for treatment?

- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ 4-5 times a week
- ○ Other - please specify [ ]

Next

19. Two examples of goals I have set for a CwGA are

20. Which (if any) of the following treatment approaches have you used with CwGA?
Please tick all that apply

- [ ] PACE (Promoting Aphasic's Communicative Effectiveness)
- [ ] VAT (Visual Action Treatment)
- [ ] BLISS Symbols
- [ ] Group Treatment
- [ ] Amer-Ind
- [ ] Total Communication
- [ ] Computer Programmes (please specify which ones in the large box below)
- [ ] None of the above
- [ ] Other - please specify here

Give any examples of computer programmes you use in treatment of CwGA here

21. Which (if any) of the following tasks have you used in the direct treatment of CwGA?
Please tick all that apply

- [ ] matching objects
- [ ] matching colours or shapes

- [ ] matching pictures
- [ ] matching words to pictures
- [ ] yes/no response practice
- [ ] matching gestures to objects
- [ ] matching gestures to pictures
- [ ] producing gesture
- [ ] tracing objects
- [ ] matching sounds to objects or pictures
- [ ] drawing
- [ ] writing
- [ ] playing cards
- [ ] playing Connect 4™
- [ ] completing jigsaw puzzles
- [ ] playing dominoes
- [ ] sorting objects by category
- [ ] making choices between objects by pointing
- [ ] None of the above
- [ ] other - please specify ______

22. Which (if any) of the following indirect approaches to treatment of CwGA have you used?
Please tick all that apply

- [ ] education to the multi-disciplinary team on how to communicate with the client
- [ ] education to the client's family on how best to communicate with the client
- [ ] modification of the environment for the CwGA
- [ ] None of the above

☐ other - please specify ☐

23. Have you ever carried out treatment sessions completely non-verbally with CwGA? (ie where you do not give any verbal directions or verbal feedback)

- ○ YES
- ○ NO

24. If there was a non-verbal therapy available (that did not allow for any verbal instructions or verbal feedback) to treat the communication impairments of CwGA, how likely would you be to consider using it?

- ○ very likely
- ○ possibly
- ○ not sure
- ○ unlikely

25. Have you as a Speech and Language Therapist ever offered cognitive treatment to CwGA?

- ○ YES
- ○ NO

Next

26. If you as a Speech and Language Therapist have offered cognitive treatment to CwGA.

What areas of cognition has your treatment targeted?
Please tick all that apply

- ☐ attention / concentration
- ☐ memory

- [ ] visual processing
- [ ] planning
- [ ] organising
- [ ] self monitoring /self regulation
- [ ] other - please specify [ ]

27. If you as a Speech and Language Therapist have treated cognition in CwGA, please give examples of tasks that you have conducted

28. Have you ever worked jointly with another member of the multi-disciplinary team to treatCwGA?

( ) YES

( ) NO

If yes, which profession

Next

29. If you have worked with another member of the multi-disciplinary team to treat CwGA, please give examples of the tasks you have conducted jointly with them

Next

30. What factors do you consider when deciding to discontinue treatment for CwGA?
Please tick all that apply

- ☐ achievement of SLT goals
- ☐ a sense that the CwGA has plateaued
- ☐ changes in language assessment scores
- ☐ self or carer reports of changes
- ☐ client motivation
- ☐ amount of treatment already offered
- ☐ other - please specify

31. Please complete the following:
One key challenge in treating CwGA in my clinical experience is

32. Please complete the following:
One area or question I feel needs more research with respect to the treatment of CwGA is

Finish

9.2 Appendix 2 Object familiarity questionnaire

Thank you for taking the time to complete this questionnaire.

You will be shown 43 pictures of objects/animals. For each picture I would like you to rate on a scale of 1 to 5 how **familiar** you are with this object/animal **(1** being **not very familiar** to **5** being **very familiar)** Complete your rating according to how usual or unusual the item is in your realm of experience. Try to rate the object ***concept*** rather than the way it looks in the particular picture.

The scale**: 1 = not very familiar with the object.**

2

3

4

5 = very familiar with the object.

Please circle your rating for each picture. Please try to use the full range of the scale.

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

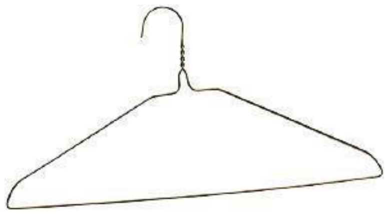
Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

Rating: 1 2 3 4 5



Rating: 1 2 3 4 5

Rating: 1 2 3 4 5

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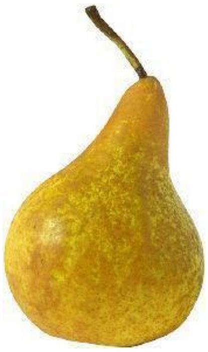
Rating: 1 2 3 4 5



Rating: 1 2 3 4 5

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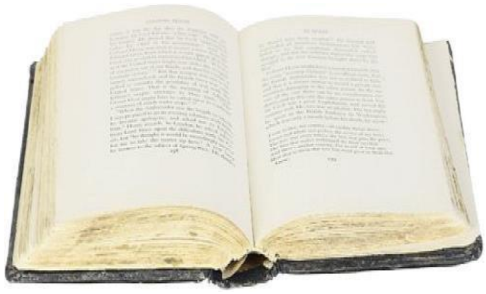
Rating: 1 2 3 4 5



Rating: 1 2 3 4 5

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Rating: 1 2 3 4 5

THE END

Thank you for your time.

9.3 Appendix 3 Intervention task materials and detailed instruction process

Task	Items used	Support / step down process
Visual Tracking	Red coloured circle	Additional demonstration with physical cues e.g. researcher moving participant's head or guiding participant's finger to track circle. Up to five independent attempts at task in total
Shift gaze with/without competition	Red and blue coloured circles	Additional demonstration with physical cues e.g. researcher moving participant's head or guiding participant's finger to track circle. Up to five independent attempts at task in total
Visual sustained attention	Pictures of Cup of tea & bed	Additional demonstration with researcher using hand over hand assistance to support participant to complete task Up to five independent attempts at task in total
Auditory sustained attention	Doorbell sound	Additional demonstration with researcher using hand over hand assistance to support participant to complete task Up to five independent attempts at task in total
Object Matching	Glass pen Spoon key Toothbrush Bowl Ball Fork Comb Coin	i) Reduce number of items from 5 to 4 and complete task for 8 items If participant scores above chance (5/8), try choice of 5 again. If scores less than chance step down: ii) Reduce number of items from 4 to 2 and complete task for 4 items If participant scores above chance (3/4) try above step (ii, object matching choice of 4) again. If participant scores less than chance, complete **practice tasks** below. iii) Match colours (2 red/blue squares) from choice of 2 Match shapes (2 black triangles/2 black circles) from choice of 2 If participant scores above chance (3/4), try above step (iii, object matching choice of 2) again. If scores below chance attempt this level up to 5 times before moving on to next task in hierarchy.

Visual selective attention	Target: Picture of dog Distractors: Bird, cat, horse, sheep, cow, lion, rabbit, pig, ball, grass, leash, apple, bus, pen, umbrella, lamp, bed, door, pear, spoon, clock	Two additional demonstrations followed by the researcher using hand over hand assistance to support participant to complete 5 examples of the task. Up to five independent attempts at task in total
Object to non-identical picture matching	Objects/pictures of: Stamp Pen Spoon Comb Mug Glasses Key Toothbrush Watch Coin	i) Reduce number of items from 5 to 4 and complete task for 8 items If participant scores above chance (5/8), try choice of 5 again. If scores less than chance step down: ii) Reduce number of items from 4 to 2 and complete task for 4 items If participant scores above chance (3/4) try above step (i) again. If participant scores less than chance, move onto next task in hierarchy (gesture to picture matching). If participant scores less than chance, complete **practice tasks** below. iii) Match non-identical objects (stamp, toothbrush, key, fork) from choice of 2 Match non-identical pictures (watch, glasses, key, bowl) from choice of 2 If participant scores above chance (5/8), try above step (ii) again. If participant still scores below chance attempt this level up to 5 times before moving on to next task in hierarchy.
Gesture to picture matching	Cup Toothbrush Comb Pen Apple Key Book	i) Reduce number of items from 5 to 4 and complete task for 8 items If participant scores above chance (5/8), try choice of 5 again. If scores less than chance step down: ii) Reduce number of items from 4 to 2 and complete task for 4 items If participant scores above chance (3/4) try above step (i) again. If participant scores less than chance, move onto next task in hierarchy (match two connected pictures). If participant scores less than chance, complete **practice tasks** below.

	Glove Scissors Tissue	iii) Match real life action of object being used to object picture (cup, scissors, key, glove) from choice of 2 If participant scores above chance (3/4), try above step (ii) again. If participant still scores below chance attempt this level up to 5 times before moving on to next task in hierarchy.
Match two connected pictures	Watch-clock Mug-glass Sock-shoe Lock-key Fork-knife Table-chair Toothbrush-toothpaste Paper-pen Window-door Lightbulb-lamp	i) Reduce number of items to choose from, from 5 to 4 and complete task for 8 items If participant scores above chance (5/8), try choice of 5 again. If scores less than chance step down: ii) Reduce number of items from 4 to 2 and complete task for 4 items If participant scores above chance (3/4) try above step (i) again. If participant scores less than chance, attempt this level up to 5 times before moving on to next task in hierarchy
Picture categorisation	<u>Fruits/vegetables</u> (Examples: apple /carrot) Orange, banana, grapes, pear, strawberry Lettuce, broccoli, cucumber, peas, sweetcorn <u>Animals / furniture</u> (Examples: dog, chair) Cat, horse, lion, sheep, cow Table, sofa, bed, desk, chest of drawers.	i) Focus on distant category only. Provide additional demonstration and hand-over hand assistance to complete two items then allow participant to re-attempt task up to three times. If participant scores above chance (6/10), re-attempt close semantic category (fruits & vegetables). If consistently scores below chance, attempt this level up to 5 times before moving on to next task in hierarchy.

Match environmental sound to pictures	Doorbell, Spoon Tap Road drill Clock Car Police siren Phone Dog Cat	i) Reduce number of items from 5 to 4 and complete task for 8 items If participant scores above chance (5/8), try choice of 5 again. If scores less than chance step down: ii) Reduce number of items from 4 to 2 and complete task for 4 items If participant scores above chance (3/4) try above step (i) again. If participant scores less than chance, move onto next task in hierarchy (gesture to picture matching). If participant scores less than chance, complete **practice tasks** below. iii) Passive listening (using all items from task list). Researcher completes task (with choice of 2 pictures) and participant passively watches and listens to hear sound that corresponds with each picture. After all sounds have been demonstrated re-attempt task above (ii) if participant still scores less than chance attempt this level up to 5 times before moving on to next task in hierarchy.
Odd One Out	<u>Close semantic category</u> Apple, banana, lettuce sweetcorn, peas, grapes Shirt, jumper, shoe Cat, horse, bird Desk, chair, toilet <u>Distant semantic category</u> Grapes, pear, chair lettuce, broccoli, shirt Coat, shirt, banana Horse, cow, lettuce Desk, chair, strawberry	i) Focus on distant category only. Provide additional demonstration and hand-over hand assistance to complete two items then allow participant to re-attempt task up to five times. If participant scores above chance (3/5), re-attempt close semantic category. However, if the participant persistently scores below chance. Move on to next task in hierarchy.

Complete the category	Participant chooses from close semantic choices 1) Targets: apple banana Choice: pear or lettuce 2) Targets: lettuce, broccoli Choice: apple or carrot 3) Targets: shirt, coat Choice: jumper or shoe 4) Targets: cat, horse Choice: dog or bird 5)Targets desk, chair Choice: sofa or toilet Participant chooses from distant semantic choices 6) Targets: orange, grapes Choice: banana or chair 7) Targets: lettuce, broccoli Choice: peas or sock 8) Targets: coat, trousers Choice: dress or strawberry 9) Targets: sheep, horse Choice: cow or sweetcorn 10) Targets: sofa, desk Choice: chest of drawers or apple	i) Focus on distant category only. Provide additional demonstration and hand-over hand assistance to complete two items then allow participant to re-attempt task up to five times. If participant scores above chance (3/5), re-attempt close semantic category. However, if the participant persistently scores below chance. Move on to next task in hierarchy.

Choose and Collect a similar item	Targets: Pictures of; 5 different watches 5 different pens <u>Distractors:</u> Banana, bed, car, cat, flower clock, bowl, glasses, fork, book bus, camera, stamp, tap toothpaste, chair, door toothbrush, apple, phone, lamp scissors, glasses	i) Reduce number of distractors from 15 to 10 If participant scores above chance (6/10), try with 15 distractors again. If scores less than chance step down: **ii)** Reduce number of distractors from 10 to 5. If participant scores above chance (6/10), try with 10 distractors again. If participant scores less than chance step down to **practicetasks** iii) choose and collect identical items. Five identical pictures of the same watch are placed in front of participant along with five distractor pictures. The client must pick the five targets only. The same is done with five identical pictures of the same watch. If the participant scores above chance 6/10 trial task ii) again. If participant persists scoring below chance after 5 attempts move on to final task in the hierarchy.
Choose and Collect from Category	1) Examples: cauliflower, carrot Targets: broccoli, lettuce, sweetcorn, pepper, onion 2) Examples: chest, chair Targets: sofa, desk, table, wardrobe, bookshelf Distractors: toilet, apple, banana, pear, bottle, tap, toothbrush, fork, knife lightbulb, clock, house, window, bird, fork, door, car, bike, lamp, stamp, hanger, toothbrush, dog	If participant scores above chance (6/10), try with 15 distractors again. If scores less than chance step down: ii) Reduce number of distractors from 10 to 5. If participant scores above chance (6/10), try with 10 distractors again. If participant scores less than chance step down

9.4 Appendix 4 INTERPReT script

OVERALL AIM : To give the client an opportunity to communicate verbally or non-verbally in controlled situations which mimic real life.

PRE-SESSION PREPARATION:

Session 1: Arrange with clients relative/friend to be present at session and to knock door 5 minutes into session, continuously for 15 seconds first softly then getting louder.

Session 2 Researcher to ask colleague or client's relative/friend to call her 5 minutes through session and to let phone ring out

Session 3 Researcher to set alarm on her phone to sound with typical alarm sound 5 minutes into session.

SESSION SCRIPT:

- Greet Client
- Offer client choice of activity by placing the 2 relevant options (from list in table below) in client's view on table, either side by side or vertically (depending on the client's needs)
  Ask "What would you like to do? X or Y?

  If the client does not respond, follow the cues below

Cue 1: Simplify verbal question to just "X or Y" and point at each option

Cue 2: If still no response ask again "X or Y?" while taking client's hand and pointing at each option

Cue 3: If still no response choose a task for the client

<table>
<tr><th>BASELINE TESTING</th><th>POST INTERVENTION TESTING</th><th>FOLLOW UP TESTING</th></tr>
<tr><td>Session 1
magazine OR newspaper</td><td>Session 1
magazine OR newspaper</td><td rowspan="3">1 Session including 3 tasks

magazine OR newspaper

jigsaw OR connect 4

snap cards OR dominoes</td></tr>
<tr><td>Session 2
jigsaw OR connect 4</td><td>Session 2
jigsaw OR connect 4</td></tr>
<tr><td>Session 3
Snap cards OR dominoes</td><td>Session 3
snap cards OR dominoes</td></tr>
</table>

- During the activity a Yes/No question e.g. Is that X? Is it my turn?
- Auditory distraction to occur after approximately 5 minutes as follows:

BASELINE TESTING	POST Tx TESTING	FOLLOW UP Testing
Session 1 progressively louder knocking on door	**Session 1** progressively louder knocking on door	**1 Session involving 3 disruption** progressively louder knockingon door AND phone ringing for extended period with unusual ringtone AND Alarm clock sound
Session 2 phone ringing for extended period with unusual ring tone	**Session 2** phone ringing for extended period with unusual ring tone	
Session 3 Alarm clock sound continuing for extended period	**Session 3** Alarm clock sound	

- Indicate to the client that they should ignore noise.

If client is distracted, remind them again to ignore distraction

If client is still distracted despite prompts, manually stop noise on phone/alarm or ask person to stop knocking.

After 2-3 further minutes create a problem during activity as follows

BASELINE TESTING	POST Tx TESTING	FOLLOW UP Testing
Session 1 knock down newspaper/magazine, pickup then re-present it upside down	**Session 1** knock down newspaper/magazine, pickup then re-present it upside down	**1 session including 3 problems**: knock down newspaper/magazine, pick up then re-present it upside down During jigsaw offer completely different piece e.g. size and colour. OR During Connect 4 pts coloured pieces are out of their reach nearer SLT During snap game pretend its snap (i.e. that cards match when they do not) OR During Dominoes break rule and connect 2 dominoes that clearly have different number of dots.
Session 2 During jigsaw offer client a completely piece from a different puzzle that differs significantly in size and colour. OR During Connect 4 offer a one pound coin rather than the client's coloured coin for their turn	**Session 2** During jigsaw offer completely different piece e.g. size and colour. OR During Connect 4 pts coloured pieces are out of their reach nearer SLT	
Session 3 During snap game pretend its snap (i.e. that cards match when they do not) OR During Dominoes break rule and connect 2 dominoes that clearly have different number of dots.	**Session 3** During snap game pretend its snap (i.e. that cards match when they do not) OR During Dominoes break rule and connect 2 dominoes that clearly have different number of dots.	

Follow the below cueing system for the relevant tasks:

Newspaper/Magazine		
Initial Instruction	Cue	Final
SLT to do nothing and continue as if item is not upside down for 5 seconds observing for pt reaction	If pt not indicting awareness of issue after 5 seconds, SLT to say "Is anything wrong?"	If no response to question, SLT to say "I think its upside down let's turn it the right way"
Jigsaw/Connect 4		
Initially	Cue	Final
SLT to do nothing and observing for pt reaction for 10 seconds.	If pt not indicting awareness of issue SLT to say " do you think this piece goes with our jigsaw?" OR "Is that the correct coin for this game?"	If still no response SLT to say "I think it's from the wrong puzzle let's take that away" OR "That's not the correct coin. You need this one (offer correct coloured coin for client).
Snap/Dominoes		
Initially	Cue 1	Cue 2
SLT to do nothing and just observe for pts reaction for 5 seconds	SLT to say "Is that right? Are they the same?	I was cheating. They aren't really the same.

9.5 Appendix 5 Research Ethics Committee approval letters

Health Research Authority

NRES Committee East of England - Essex
The Old Chapel
Royal Standard Place
Nottingham
NG1 6FS

Telephone: 0115 8839695

22 September 2014

DR SUZANNE BEEKE
UCL RESEARCH DEPARTMENT OF LANGUAGE AND COMMUNICATION
CHANDLER HOUSE, 2 WAKEFIELD STREET
LONDON
WC1N 1PF

Dear Dr Beeke

Study title:	**An investigation into the effect of a novel, non-verbal cognitive treatment on functional communication in global aphasia.**
REC reference:	**14/EE/1076**
Protocol number:	**n/a**
IRAS project ID:	**133061**

Thank you for your letter of , responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to make a request to postpone publication, please contact the REC Manager, Miss Helen Wakefield, nrescommittee.eastofengland-essex@nhs.net.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Mental Capacity Act 2005

I confirm that the committee has approved this research project for the purposes of the Mental Capacity Act 2005. The committee is satisfied that the requirements of section 31 of the Act will be met in relation to research carried out as part of this project on, or in relation to, a person who lacks capacity to consent to taking part in the project.

Conditions of the favourable opinion

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non clinical trials this is not currently mandatory.

If a sponsor wishes to contest the need for registration they should contact Catherine Blewett (catherineblewett@nhs.net), the HRA does not, however, expect exceptions to be made. Guidance on where to register is provided within IRAS.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).
Non-NHS sites

The Committee has not yet completed any site-specific assessment (SSA) for the non-NHS research site(s) taking part in this study. The favourable opinion does not therefore apply to any non-NHS site at present. We will write to you again as soon as an SSA application(s) has been reviewed. In the meantime no study procedures should be initiated at non-NHS sites.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Copies of advertisement materials for research participants [SLT collaborator information sheet]	1.0	24 March 2014
Covering letter on headed paper [REC Response letter]	1.0	05 September 2014
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Insurance certificate]		
GP/consultant information sheets or letters [GP Information Sheet]	1.0	24 March 2014
IRAS Checklist XML [Checklist_10092014]		10 September 2014
Letter from statistician [notes from methodology discussion]	1.0	30 May 2014
Letters of invitation to participant [Letter of invitation]	1.0	30 May 2014
Other [Script for CIT]	1.0	24 March 2014
Other [Aphasia Screening Test Assessment]		
Other [Treatment programme]	1.0	24 March 2014
Other [Insurance confirmation letter]		
Other [CAT Repetition subtest]		
Other [Pyramids and Palm Trees Assessment]		
Participant consent form [consultee declaration form]	2.0	16 August 2014
Participant consent form [consent form relatives/friends]	1.0	30 May 2014
Participant information sheet (PIS) [consultee information sheet]	2.0	16 August 2014
Participant information sheet (PIS) [Participant information sheet]	2.0	16 August 2014
Participant information sheet (PIS) [Information Sheet for realtives_friends]	1.0	30 May 2014
REC Application Form [REC_Form_15072014]		15 July 2014
Referee's report or other scientific critique report [peer review letter Beeke]	1.0	18 March 2014
Referee's report or other scientific critique report [independent review]	1.0	04 September 2014
Research protocol or project proposal [Research Protocol]	2.0	16 August 2014
Summary CV for Chief Investigator (CI) [CV Beeke]	1.0	10 July 2014
Summary CV for student [CV Sharon Adjei]	1.0	30 May 2014
Summary CV for supervisor (student research) [CV Sacchett]	1.0	10 July 2014
Summary, synopsis or diagram (flowchart) of protocol in non technical language [Timeline]	1.0	30 May 2014
Validated questionnaire [Questionnaires/Assessments: ASHA-Facs, WAB, BNVR, WCST]		
Validated questionnaire [SDSS Assessment]		

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website:
http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at http://www.hra.nhs.uk/hra-training/

14/EE/1076	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project.

Yours sincerely

[redacted]

Dr Alan Lamont
Chair

Email:nrescommittee.eastofengland-essex@nhs.net

Enclosures: "After ethical review – guidance for researchers" *[SL-AR2]*

Copy to: *Ms Suzanne Emerton, Joint Research Office UCL*

Health Research Authority

NRES Committee East of England - Essex
The Old Chapel
Royal Standard Place
Nottingham
NG1 6FS

Tel: 0115 8839695

18 June 2015

DR SUZANNE BEEKE
UCL RESEARCH DEPARTMENT OF LANGUAGE AND COMMUNICATION
CHANDLER HOUSE, 2 WAKEFIELD STREET
LONDON
WC1N 1PF

Dear Dr Beeke

Study title:	**An investigation into the effect of a novel, non-verbal cognitive treatment on functional communication in global aphasia.**
REC reference:	**14/EE/1076**
Protocol number:	**n/a**
Amendment number:	**1**
Amendment date:	**07 May 2015**
IRAS project ID:	**133061**

The above amendment was reviewed on 12 June 2015 by the Sub-Committee in correspondence.

Ethical opinion

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

The sub committee agreed the amendment presented no ethical issues.

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Covering letter on headed paper		07 May 2015
Notice of Substantial Amendment (non-CTIMP)	1	07 May 2015
Participant consent form [consultee declaration]	3	07 May 2015
Participant information sheet (PIS) [consultee]	3	07 May 2015

Participant information sheet (PIS)	3	07 May 2015
Research protocol or project proposal	3	07 May 2015

Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

R&D approval

All investigators and research collaborators in the NHS should notify the R&D office for the relevant NHS care organisation of this amendment and check whether it affects R&D approval of the research.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

14/EE/1076:	**Please quote this number on all correspondence**

Yours sincerely

[redacted]

Dr Alan Lamont
Chair

E-mail: NRESCommittee.EastofEngland-Essex@nhs.net

Enclosures: *List of names and professions of members who took part in the review*

Copy to: *Ms Suzanne Emerton, Joint Research Office UCL*

NRES Committee East of England - Essex

Attendance at Sub-Committee of the REC meeting on 12 June 2015

Committee Members:

Name	*Profession*	*Present*
Dr Alan Lamont (Chair)	Consultant Oncologist	Yes
Ms Sarah Starr	Senior Nurse	Yes

Also in attendance:

Name	*Position (or reason for attending)*
Helen Poole	REC Manager

9.6 Appendix 6 Consultee information sheet

RESEARCH DEPARTMENT OF LANGUAGE AND COMMUNICATION
University College London
Chandler House,
2 Wakefield Street,
London WC1N 1PF

Title of Research

An investigation into the effect of a novel non-verbal cognitive treatment on functional communication in global aphasia (Student Study)

Study Number **13/0581**
Chief Investigator **Dr Suzanne Beeke email s.beeke@ucl.ac.uk**
Research Student **Sharon Adjei [redacted] email s.adjei.12@ucl.ac.uk**

INFORMATION FOR CONSULTEE

Invitation and Summary

We would like to invite your relative/friend to take part in the above research study. The study is for people who have global aphasia i.e. find it difficult to interact, understand, speak, read, write or use alternative forms of communication like pointing, gesture or pictures after they have had a stroke. Your relative/friend's speech and language therapist has identified them as having global aphasia and feels that they may benefit from taking part in this study. This research is specifically designed for people with global aphasia and will see whether a new therapy programme can help your relative/friend interact and communicate better.

We feel your relative/friend is unable to decide for himself/herself whether to participate in this research.

To help decide if he/she should join the study, we would like to ask your opinion whether or not they would want to be involved. We ask you to consider what you know of their wishes and feelings, and to consider their interests. Please let us know of any advance decisions they have made about participating in research. These should take precedence.

If after reading this information sheet you decide your relative/friend would have no objection to taking part we ask you to contact the researcher Sharon Adjei who will visit you and your relative/friend at home. At this visit Sharon will ask you to read and sign the consultee declaration on the last page of this information leaflet. She will give you a copy to keep and will keep you fully informed during the study so you can let her know if you have any concerns or you think your relative/friend should be withdrawn.

If you decide that your friend/relative would not wish to take part you do not have to do anything further. It will not affect the standard of their current or future care in any way.

If you are unsure about taking the role of consultee you may seek independent advice.

We will understand if you do not want to take on this responsibility.

The following information is the same as would have been provided to your relative/friend if they had capacity to decide for themselves.

Part 1 tells you the purpose of this study and what will happen to your relative/friend if they take part.

Part 2 gives you more detailed information about the conduct of the study.

You can ask **Sharon Adjei** (Researcher and Speech & Language Therapist) if the information is not clear or if you want more information by:

Phone: [redacted]
Email: s.adjei.12@ucl.ac.uk

PART 1: This section explains:

1. Why I am doing this research
2. What your role and the role of your relative/friend would be

What is the purpose of this research?

Some people like your relative/friend find it difficult to communicate in any way after they have had a stroke. This is called global aphasia and affects understanding, speaking, reading and writing. It also affects people's ability to interact with others or use alternative forms of communication like pointing, gesture or pictures.

There have been very few research studies that have looked at therapy for people with global aphasia. In fact most research excludes people with global aphasia.
This research is specifically designed for people with global aphasia and will see whether a new treatment programme can help them interact and communicate better.

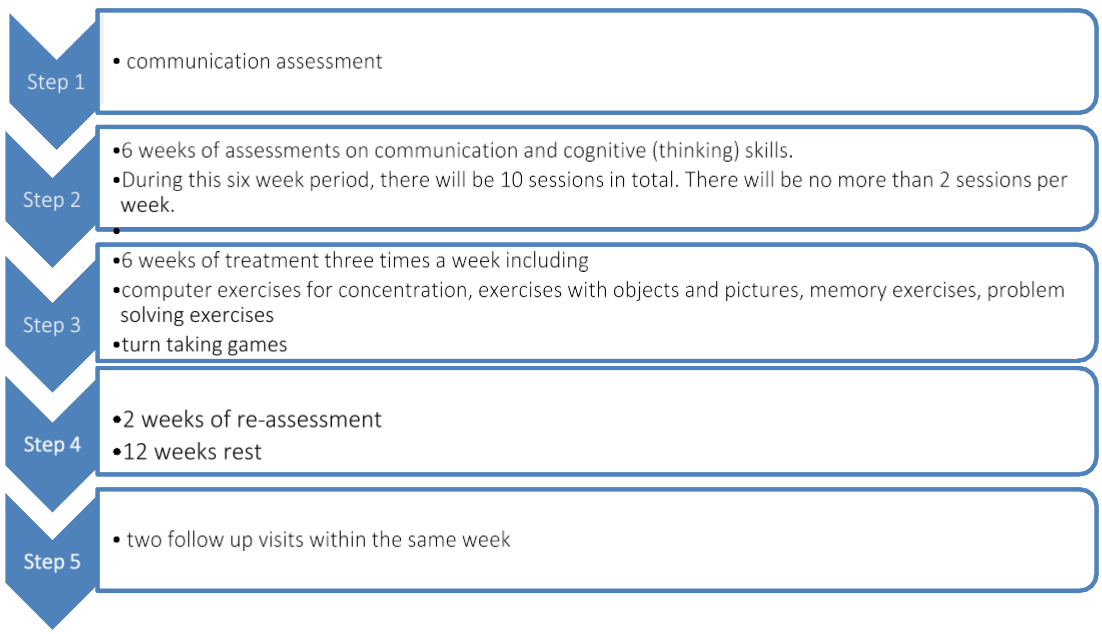
Why my relative/friend?

Your relative/friend has been identified by their current or past speech and language therapist as having global aphasia. They think s/he may be suitable for this study and able to benefit. Up to eight people with global aphasia will be involved in the study.

What would taking part involve for my relative/friend?

Firstly your relative/friend will be visited at home by Sharon. You will also be present for this session. Sharon will attempt to explain the study to your relative/friend and will also complete a communication assessment with them. The assessment results will be used to establish their current communication skills. After this assessment Sharon may decide that they are not suitable for the study, Sharon will call you within one week of the visit to let you know and no further involvement will be required. If your relative/friend is deemed suitable, the research will happen in the place of residence of your relative/friend at a convenient time. In total they will be involved for 14 consecutive weeks, then have a 12 week break and be seen twice more.

In summary there are five steps to their involvement. These are summarised in the flow chart and explained in more detail below.



Step 1 (1 session only)

Sharon will visit your relative/friend once to explain the study and assess their current communication skills using an assessment called the Western Aphasia Battery (Kertesz 2006). This visit will take approximately an hour. If they are appropriate to continue with the study they will be told within one week after this first session and a date will be set for them to start the further steps. The length of time between step 1 and step 2 will depend on when it is convenient for your relative/friend and Sharon to start the study.

Step 2 (6 weeks long):

Sharon will visit your relative/friend ten times over a 6 week period (see table 1) to assess their communication and cognitive (thinking) skills. Each visit should last about 45 minutes but will be adjusted to take account of your relative/friend's ability to concentrate and tiredness levels. Three of these visits will involve Sharon setting up a tripod and video camera in the room the session is taking place in order that she can video herself and your relative/friend interacting, for example looking at a magazine together or playing a game like dominoes together. You do not have to be present for these assessments, but you can be if you wish. Other visits will involve your relative conducting communication and cognitive tests.

The assessments are
-Aphasia Screening Test (AST)(Whurr 1996) which assess comprehension, expression, reading and writing
-Pyramids and Palm Trees (Howard and Patterson 1992) which assesses understanding of pictures
-Wisconsin Card Sorting Test (WCST) (Grant and Berg 1981).This is a cognitive assessment. -
-Butt Non Verbal Reasoning Test. (Butt and Bucks 2004) This is an assessment of reasoning and problem solving.
-Repetition Test from the Comprehensive Aphasia Test (Swinburn, Porter & Howard 2004). This is an assessment of ability to repeat words.

Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**
2 sessions	2 sessions	2 sessions	1 session	2 sessions	1 session

Table 1: Summarising Step 2

Step 3 (6 weeks long):

Sharon will then visit your relative/friend **3 times a week for 6 weeks** in their place of residence to carry out therapy. The tasks are ordered hierarchically. Once your friend/relative starts the first task, Sharon will monitor their performance and develop the therapy programme exactly to suit their needs and abilities. Your relative/friend will only move to the next task when they have reached a specific level. If they are finding a particular tasks very difficult additional practice tasks may be carried out.

Some tasks are carried out on a laptop others use pictures objects or games. This is the ordered list of therapy tasks

- visually tracking a picture as it moves across the computer screen
- pressing a button every time a picture is seen on the screen
- playing dominoes and snap
- pressing a button every time a specific picture is seen on the screen
- Pressing a button every time a specific sound is heard
- Matching objects to a picture
- Matching gestures to objects
- Matching two connected objects

- Sorting objects by categories
- Matching sounds to objects
- "Complete the category" and "odd on out with objects"
- Choosing target objects by pointing
- Choosing objects to complete the category by pointing

You do not have to be present for these sessions, but you can be if you wish. All the sessions will need to be video-recorded therefore a tripod and camera will be set up in the room where each session is taking place. Each session will last approximately 45 minutes.

Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
3 Treatment sessions	3 Treatment sessions	3 Treatment sessions	3 Treatment sessions	3 Treatment sessions	3 Treatment sessions

Table 2: Summarising Step 3

Step 4 (2 weeks of sessions and a 12 week break)

After the therapy, Sharon will assess your relative/friend again using the same communication and cognitive tests that were used at the beginning of the study in step 1. This time there will be **4 sessions spread over 2 weeks**. Each session will last approximately 45 minutes.
There will also be one final video recorded interaction session with Sharon. Again this will require a tripod and video camera to be set up in the room where this session will take place. After this your relative/friend will have a **break for 12 weeks** when he or she does not see Sharon at all.

Week 13	Week 14	Week 15-26
3 VISITS	ONE VISIT	REST for 12 WEEKS

Table 3: Summarising Step 4

Step 5 (Two follow up visits)

After the 12 week break Sharon will visit your relative/friend for two follow up sessions. This will involve Sharon making one final video-recording while interacting with your relative/friend. Once again this session will require setting up of a tripod and video recorder in the room. Your relative/friend will also have to carry out some of the language and thinking tests again (Butt Non Verbal Reasoning Test, Pyramids and Palm Trees, Repetition). Then this will be the end of the research project for yourrelative/friend.

What are the possible benefits of my relative/friend taking part?

They will receive one-to-one therapy from a trained highly specialist speech and language therapist with experience of working with people with global aphasia. The therapy has been specifically designed for people like your relative/friend who have global aphasia.

After treatment your relative/friend may improve in their ability to do one or more of these things:

- concentrate on an activity,
- take turns in an activity,
- recognise objects
- understand pictures
- understand gestures
- recognise when there is aproblem
- use pointing or pictures or objects to communicate
- understand what has happened to them and their abilities
- understand theirenvironment

Their mood may alsoimprove.

However some people may not improve in any of these areas and their communication may stay the same. We can not predict whether your relative/friend will improve or not but we know that it is very unlikely that their communication will get worse.

Taking part will not affect your relative/friend’s access to therapy or healthcare in the future.

What are the possible disadvantages and risks of taking part?

The intervention programme has been designed to be engaging and fun. There are 15 tasks in the programme so there is a wide variety of tasks, of which some are computer (lap-top) based. The researcher takes turns and/or interacts with the client (non-verbally) in many of the tasks so there is continuous engagement and feedback. It is unlikely your relative/friend will experience significant harm from participating in the study. However there is a possibility that they could experience

1) distress in carrying out assessments and therapy tasks that find difficult
2) boredom from conducting repetitive assessments and therapy tasks
3) distress from being video recorded
4) anxiety/distress/depression from increased insight and awareness of their difficulties
5) burden of having to have three treatment sessions per week and potential disruption to daily routines
6) low mood from any or all of the above

Sharon is experienced with working with people with global aphasia and has considered all of the above potential risks/burdens and taken actions to try and limit them. For example:

In every session with the participant, Sharon will monitor the engagement, facial expression and body language of participants to look for any signs of objection toparticipation.

Sharon will keep written records of each session which will include comments on mood, engagement and non-verbal behaviours. This will help Sharon monitor any change in these behaviours.
If your relative/friend lives in a nursing home/or care-home settings, Sharon will review their care notes and speak to their carer to ascertain if there have been any changes to their behaviour/mood after or between sessions and this will be monitored.

You will have Sharon's contact details and can contact her at any time to express concern and/or withdraw your relative/friend from the study.

Withdrawal from the study

Apart from you requesting your relative/friend to be withdrawn from the study, participants can also be withdrawn from the study if they

- become medically unwell and are unable to participate in the study for more than 2 consecutive weeks.
- show persistent signs of disengagement/low mood/objection to carrying out treatment with the SLT for 2 consecutive weeks.
- move during the treatment to a place which is not practical for the researcher to travel to

What happens when the research project stops?

When the study ends no more therapy will be available from the project. However if your relative/friend has benefitted from the therapy they may be able to receive more from their local NHS speech and language therapy service. Sharon will help you to re-refer your relative/friend if you do not know how to do this.

Can my relative/friend be receiving therapy at the same time as being in this study?

Unfortunately your relative/friend can not be receiving any other form of therapy or rehabilaition at the same time as this study. They can continue with any medical intervention that they are receiving.

Can my relative/friend take part in other research as the same time as being in this study?

It is fine if your relative/friend has been involved in research before and you feel that they would also wish to take part in this study. However your relative/friend can not be involved in any other research related activity whilst they are involved in this study.

What if there is a problem?

Any complaint about the way your relative/friend has been dealt with during the study or any possible harm they might suffer will be addressed. The detailed information on this is given in Part

2.

Will the participation of my relative/friend be kept confidential?

Yes. Ethical and legal practice will be followed. All information about your relative/friend will be handled in confidence. The details are included in Part 2.

This is the end of Part 1.

If the information in Part 1 has interested you and you are considering the participation of your relative/friend, please read the additional information in Part 2 before making any decision.

PART 2: ADDITIONAL INFORMATION ABOUT THE RESEARCH PROJECT

What will happen if I don't want my relative/friend to carry on with the study?

If your relative/friend stops taking part the video recordings made up to that point will be kept. If your relative/friend becomes ill or no longer wants to take part the video recordings carried out up to that point will be kept. Stopping the study will have no impact on your relative/friends current or future care.

What if there is a problem or something goes wrong?

If you have a concern about any aspect of the study you should phone/email the researcher Sharon on [redacted]s.adjei.12@ucl.ac.uk. Alternatively you can phone the chief investigator **Dr Suzanne Beeke** on 020 7679 4215 or email s.beeke@ucl.ac.uk.

If you are still unhappy and wish to complain, UCL complaints mechanisms are available to you. You can write to:

Mr David Wilson,
Joint Research Office
University College London
1stFloor, Maple House
Suite B
149 Tottenham Court Road
London W1T 7DN

Will the participation of my relative/friend be kept confidential?

Yes. All information about them will be kept strictly confidential. We will follow the rules of the Data Protection Act 1998. Their name, address and telephone number will be kepton an encrypted hard-drive at UCL, which only Sharon Adjei can access using a password. This information will be destroyed as soon as they complete the study. The video recordings will be kept on an encrypted hard-drive and they will also be stored in the UCL human Communication Audio-Visual Archive (CAVA) at the UCL Library for other responsible researchers to use for research or teaching, either:

a) until 3 years after the project finishes

OR

b) for as long as the library exists.

You can decide on behalf of your relative/friend which of these options is right for them.

Authorised people from UCL may look at information we collect about you to check that the study is being carried out correctly. All will have a duty of confidentiality to your relative/friend.

Involvement of the General Practitioner/Family Doctor (GP)

If you agree, your relative/friend's GP will be informed that they taking part in the study. This is all they will know, they will not be told how your relative/friend performs. If you agree Sharon may also ask your permission to inform their GP if a health issue arises e.g. persistent low mood or distress.

What will happen to the results of the research study?

The results of this research will be written up for Sharon's doctorate award and for publication in peer reviewed scientific journals. Sharon will also make the results available to the aphasia community via the paper/online publications of the following user groups: Stroke Association , Different Strokes, Speakability and British Aphasiology Society.

The results may also be verbally presented at conferences. Your relative/friend will be given a false name in anything we write or present about them. When we write and talk about the research, we will use their false name not their real name.

You will receive a summary document of the findings and your relative/friend will receive an easy to follow aphasia friendly summary of the results.

Short clips from the videos will be watched by Speech and Language Therapists, Speech and Language Therapy students and other researchers at conferences and for teaching. The face of your relative/friend will not be blanked out on the videos because we need to see their eyes and mouth as they communicate. This means therapists, researchers or students might recognise them, but it is very unlikely. In the unlikely situation that someone does recognise your relative/friend in a video, they will be reminded about their duty of confidentiality.

How have patients and public been involved in this study?

Relatives and friends of other people with global aphasia have been consulted about this study. The assessments and therapy tasks that will be used in this study have all been tried with other people with global aphasia. Speech and Language Therapists who work with people with global aphasia and research experts in the field have also been consulted.

What if relevant new information becomes available?

It is unlikely that new information would emerge during the study that would be relevant to your relative/friend's continued participation. However, should this scenario arise, Sharon will inform you by telephone and also write to you to inform you of this new information.

Who is organising and funding the research?

University College London is sponsoring and organising the research. Neither the researcher or the Speech and Language Therapist who referred your relative/friend for this study are being paid to be involved**.**

Who has reviewed the study?

All research in the NHS is looked at by independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by______________Research Ethics Committee.

Further information and contact details

1) For General Information about Research:

INVOLVE is an organisation that supports user participation in research. Find out more about getting involved in research in general **either** via their website: http://www.invo.org.uk/find-out-more/getting-involved/ or phone: **023 8065 1088.**

2) For Specific Information about this research

Contact Sharon Adjei on 07984 186676 or email her at s.adjei.12@ucl.ac.uk

3) For Advice as to whether or not your relative/friend should participate

Contact Sharon Adjei (details above)
OR
The local NHS Speech and Language Therapist who referred them at

____

4. If you are unhappy with the study

Initially contact Dr Suzanne Beeke on 020 7679 4215 or email s.beeke@ucl.ac.uk

Alternatively, you can write and make a formal complaint to:
Mr David Wilson,
Joint Research Office
University College London
1stFloor, Maple House
Suite B
149 Tottenham Court Road
London
W1T 7DN

Full contact details

Project Supervisor
Dr Suzanne Beeke
Chandler House
2 Wakefield Street
London
WC1N 1PF
Tel 020 7679 4215

Email s.beeke@ucl.ac.uk

Researcher

Sharon Adjei
Chandler House
2 Wakefield Street
London
WC1N 1PF

s.a djei.12@ucl.acuk

End of Part 2

Thank you for reading this information.

9.7 Appendix 7 Participant information sheet

RESEARCH DEPARTMENT OF LANGUAGE AND COMMUNICATION
Division of Psychology And Language Sciences
University College London
Chandler House,
2 Wakefield Street, London
WC1N 1PF

Study Number **13/0581**

Chief Investigator **Dr Suzanne Beeke email s.beeke@ucl.ac.uk**

Research Student **Sharon Adjei [redacted] email s.adjei.12@ucl.ac.uk**

PARTICIPANT INFORMATION SHEET

An evaluation of a new non-verbal treatment for global aphasia.

I **invite** you to take part in this **research study**.

This information sheet will **help you decide *if*** you want to **take part.**

Before you **decide** we want you to **understand:**

1. Why the **research** is being **done**

2. What you would have to **do**

SHARON ADJEI
Is a researcher and a **speech and language therapist**.

She will **talk** to you about this **information** sheet.

Ask her any **questions** you need to.

Speak to **friends and family** about this research if you can.

<u>We know that you may find it difficult to understand this information.</u>
<u>We know that you may need a relative/friend to decide for you.</u>

PART 1: THIS SECTION EXPLAINS:

1. Why this research study **matters**

2. What **you** will have to **do**

Why are we doing the research?

Some people like you find it **difficult to communicate** in any way after they have had a **stroke.**

This is called **global aphasia.**

Global aphasia affects **understanding, speaking, reading, writing**.

It also affects people's ability to **communicate** with others or use **pointing, gesture** or **pictures**.

This research aims to **help** people with global aphasia **communicate better.**

Why me?

Your **speech and language therapist** thinks you have global aphasia.

They think that **you** may **benefit** from this **research.**

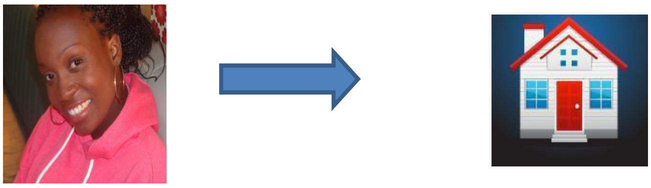
Up to **8 people** with global aphasia will take part in the study**.**

Do I have to take part?

No. It is voluntary. You do not have to take part. Even after you have started the study you can change your mind and ask to stop.

What will happen if I take part?

Sharon Adjei will **visit you** and your **relative/friend** at **home**.



You and your relative/friend will be able to ask **questions**.

Sharon will ask you to do a communication **test** so she knows how you are currently doing.

Your relative or friend will **sign a form** to say you can take

Then Sharon will go away for **one week** to **confirm** whether you can take part.

After **one week** Sharon will let you know if you can take part and will arrange when you can **start**.

You or your relative/friend can change your minds and you can stop taking part at any time.

Then

Sharon will visit you at **home** to do some **tests**. This will last **6 weeks.**

Then you will have this new therapy at home for **6 weeks**.

Then you will have a **12 week break.**

Then you will be seen **twice more.**

Therefore there are **five steps** to the research.

STEP 1

You will be seen **ONCE** for about **one hour.**

You will do a **language test**

STEP 2 **6 weeks** of assessments.

You will be seen **10 times** over **6 weeks** for about **45 minutes** each time**.**

You will do **language** and **thinking assessments.**

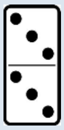
You will be **videoed** communicating with Sharon **3 times**

HERE IS A LIST OF THE THERAPY EXERCISES YOU MIGHT DO

- **Looking** at pictures as on the computer screen and 

  pressing a **button** 

- playing **dominoes** and **snap**

- **Listening** to sounds 

- **Matching** objects, gestures and pictures  

- **Sorting** objects

- **Choosing** objects by **pointing** 

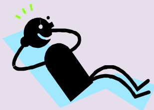
Once you start the first task, Sharon will watch how you are doing very carefully and develop the therapy programme exactly to suit your needs and abilities.

STEP 4

You will be seen **4 times** over **2 weeks**.

You will do **language** and **thinking assessments** again.

You will be **videoed** communicating with Sharon **once**.



You will have 12 weeks **rest.**

STEP 5

Sharon will **video you** communicating with her one last time.

You will do some of the **language** and **thinking assessments** again.

What are the possible disadvantages and risks of taking part?

You may find some of the therapy tasks **hard or boring.**

But there are **different levels** to help you and the therapy is **fun**

You may **not** like being **videoed**. You **do not** have to look at it. The video is for **Sharon** to watch.

You may find having **therapy** three times a week **too much.**

It may **disrupt** your normal **routine.**

Sharon will talk to your family and friends to make sure she sees you at the **best time** for you.

You may notice your **problems**.

Sharon will observe you during sessions and keep records of how you are getting on. If she is worried about you Sharon will **talk** to your **relative/friend.** If it is **bad,** Sharon will **ask** if she can tell your **doctor.**

If necessary you can **stop** the study early**.**

What are the possible benefits of taking part?

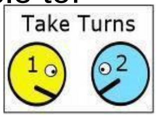
Taking part **does not** affect your **care** or getting **therapy** in the future.

Your communication will **not** get **worse.** It could **get better or** it could **stay the same**.

You will receive 1:1 **therapy** from Sharon.

Sharon is a trained and experienced **speech and language therapist**.

You may get **better** at being able to:



- **concentrate**
- **take turns**
- **recognise objects**
- understand **pictures**
- understand **gestures**
- use **pointing**, **pictures** or **objects** tocommunicate

Your **mood** may improve or you may **understand** more about your **stroke** and what you can and can not do.

You may understand better what is **going on around you.**

But you may not improve. You may **stay the same. We don't know** who will get better and who will stay the same.

What happens when the research project stops?

When the therapy **ends**, **no more** therapy will be available from the project.

However **if your communication gets better**, you may be able to have more **speech and language therapy** from the **NHS.**

Can I have speech therapy at the same time as this study?

No. You can **not** be doing any type of rehabilitation when you are doing this study.

Can I do other research as the same time as this study?

It doesn't matter if you have taken part in research before but you can **not** be taking part in any research at the same time as you are doing this study.

What if there is a problem?

We promise to deal quickly with any **complaints** from you.

We tell you how in **Part 2.**

Will my taking part be kept confidential?

Yes. All information about you will be kept **private** and **confidential.**

We will tell you **more** in **Part 2**.

THE END OF PART 1.

Still interested? Please read Part 2

PART 2: MORE DETAILS ABOUT THE RESEARCH PROJECT

What will happen if I want to stop?

If you **stop therapy** we will **keep** your **therapy videos.**

What if there is a problem?

First phone the chief investigator **Dr Suzanne Beeke**,

on 020 7679 4215 

or get help to **email** her at s.beeke@ucl.ac.uk

If you are still **unhappy** and wish to **complain** ask your relative/friend to help you **write** to:

Mr David Wilson,
Joint Research Office
University College London
1st Floor, Maple House
Suite B
149 Tottenham Court Road
London

W1T 7DN

Will my participation be kept confidential?

Yes.

All information about you will be kept **strictly confidential**.

We will follow the **rules** of the **Data Protection Act 1998**.

Your **name, address and telephone number** will be kept **safe** on a **computer** at UCL.

People will need a **password** to read it.

We will **destroy** this information as soon as you have **finished** your **therapy.**

The video recordings will be **kept** on an **encrypted computer AND** kept in the **UCL human Communication Audio-Visual Archive** (CAVA) at the **UCL Library**, **either:**

1. until **3 years** after the project finishes

OR

2. as long as the **Library** exists.

You decide.

Other **researchers** or **students** can use **videos in CAVA** for **research.**

You decide if you are happy about this.

People from **UCL** may **check** your **information** to see that the research is being done properly.

Involvement of your doctor

If you agree, we will tell your **doctor** that you are **taking part** in the study and if you become **distressed** during the study. But we will **not** tell them **how you get on**.

What will happen to the results of the study?

The results of this research will be **written up** for Sharon's doctorate award and for journals.

The results will be talked about at **conferences**

They may also appear in stroke related **magazines** or **websites.**

When we **write** and **talk** about the research, we will **use** a **false** name **not** your **real** name.

You will receive an easy to read **copy** of the results.

Clips from the **videos** will be watched at **conferences** and used for **teaching**.

Your **face** will **not** be **blanked** out on the videos because we need to **see** your **eyes** and **mouth**.

People might **recognise** you, but it is very unlikely.

If they do recognise you, they will be reminded to keep it **confide**

How have patients and public been involved in the study?

Other people who have global aphasia have **tried** the therapy exercises.

Sharon has talked to speech therapists and relatives/friends of people with aphasia about the study.

What if relevant new information becomes available?

This is **not likely.** If it does happen Sharon will **let you know.**

Who is organising and funding the research?

University College London are sponsoring and organising the research.

Who has reviewed the study?

All research connected to the NHS is looked into by a **group of independent people** called a **Research Ethics Committee.**

This is to **protect your interests**.

This study has been reviewed by______________________ and they think it is ok.

Further information and contact details

General Information about Research:

INVOLVE helps people take part in research.

Find out more: http://www.invo.org.uk/find-out-more/getting-involved/

Or phone: **023 8065 1088**

2. For Specific Information about thisresearch

Contact **Sharon** Adjei on [redacted] or email her at **s.adjei.12@ucl.ac.uk**

3. For Advice as to whether you should take part contact

Sharon Adjei on [redacted] or email her at **s.adjei.12@ucl.ac.uk**

Or your NHS Speech and Language Therapist:

____

4. If you are unhappy with thestudy

First contact Dr **Suzanne Beeke**

On **020 7 679 4215**

s.b eeke@ucl.a

c.uk or

Ask a relative/friend to help you write a letter to:
Mr David Wilson,
Joint Research Office
University CollegeLondon
1stFloor, Maple House
Suite B
149 Tottenham Court Road
London
W1T 7DN

THE END OF PART 2

Thank you.

9.8 Appendix 8 Information sheet for relatives/friends of PwGA

RESEARCH DEPARTMENT OF LANGUAGE AND COMMUNICATION
University College London
Chandler House,
2 Wakefield Street,
London WC1N 1PF

Title of Research

An investigation into the effect of a novel non-verbal cognitive treatment for functional communication in global aphasia (Student Study)

Researcher **Dr Suzanne Beeke email s.beeke@ucl.ac.uk**

Student **Sharon Adjei [redacted] email s.adjei@nhs.net**

INFORMATION SHEET FOR RELATIVES/FRIENDS OF PEOPLE WITH GLOBAL APAHSIA
Title of Research

An investigation into the effect of a novel non-verbal cognitive treatment for functional communication in global aphasia (Student Study)

Invitation and Summary

We would like to invite you to take part in the above research project with your family member or friend who has global aphasia after a stroke. People who have global aphasia find it difficult to interact, understand, speak, read, write or use alternative forms of communication like pointing, gesture or pictures. Their speech and language therapist has identified that they may be appropriate for the above study.
Before you decide whetehr you would like to participate in the research alongside your relative/friend you need to understand:

• why we are doing the research
• what you have to do

Sharon Adjei (Research student) will talk you through this information sheet. Talk to your family and friends about the research also.
Part 1 of this information sheet tells you the aims of the research and what will happen to you if you take part. Part 2 gives you more details about the research project. Ask Sharon questions if:

• you do not understand something
• you need more information

Take time to think -do you want to take part in this research?

If you are unsure about taking part you may seek independent advice.

The following information provides you with more detail to enable you to make an informed decision.

Part 1 tells you the purpose of this study and what will be involved for you.

Part 2 gives you more detailed information about the conduct of the study.

You can ask **Sharon Adjei** (Researcher and Speech & Language Therapist) if the information is not clear or if you want more information by:

Phone: [redacted]
Email: s.adjei.12@ucl.ac.uk

PART 1: This section explains:

1. Why I am doing this research
2. What your role and the role of your relative/friend would be

What is the purpose of this research?

Some people like your relative/friend find it difficult to communicate in any way after they have had a stroke. This is called global aphasia and affects understanding, speaking, reading and writing. It also affects people's ability to interact with others or use alternative forms of communication like pointing, gesture or pictures.

There have been very few research studies that have looked at therapy for people with global aphasia. In fact most research excludes people with global aphasia. This research is specifically designed for people with global aphasia and will see whether a new treatment programme can help them interact and communicate better. Your relative/friend has been identified by their current or past speech and language therapist as having global aphasia. They think s/he may be suitable for this study and able to benefit. Up to eight people with global aphasia will be involved in the study.

Unfortunately due to the severity of their impairments, people with global aphasia can not express for themselves how they are feeling or if the therapy is changing their communication. Therefore in order to measure the effect of the new therapy each participant will need to have a relative or friend who is also part of the study.

Why me?

Your relative/friend has been idenitifed by their speech and language therapist as having global aphasia and being potentially suitable for this study. You are someone whoknows themwell and regularly interacts with them so you may be able to tell us if/how their communication and interaction is changing.

What would taking part involve for me?

there are four steps to yourr involvement. These are summarised in the flow chart and explained in more detail below.

Step 1
- informal disccussion about how you communciate with your relative/friend

Step 2
- One telephone call or visit before your relative/friend ahs therapy. This will invovle you completing two questionnaires. One will be about about your relative/friedns commucniation and the other about their mood.

Step 3
- One telephone call or visit before immediately after your relative/friend has had their 6 weeks of therapy. This wil invovle you completing the same two questionnaires as ub steo 2.

Step 4
- **12 weeks rest for you and your reltive. Foolowed by one telephonce call or visit where you will beaskeed to compklete the same tqo questionnaires one final time.**

Step 1 (1 session only)

You and your relative/friend will be visited at home by Sharon. Sharon will go through this information sheet with you and answer any questions you may have. She will have a brief discussion with you asking how you currently communicate with your relative/friend and how they respond to you. She will then ask you to sign a consultee declarationt form, Within a week of this visit, Sharon will contact you to confirm whetehr you and yor relative/friend can take part or not. It may be that Sharon deems your relative/friend unsuitable for the study. In this case you will not need to take part and do not have to do anything else. If your relative/friend is deemed suitable to take part you will also participate you will continue to step 2, 3 and 4. The time between step 1 and 2 will depend on when a mutually convenient time for you, your relative/friend and Sharon can start the study.

Step 2 (1 session):

Sharon will contact you when your relative/friend is starting step 2 of their part in the study to complete a questionnaire aboutyourrelatives communication and mood. You can complete these questionnaires over the phone or in person whatever is best for you. It should take no more than 45 minutes for you to do these.

Step 3 (1 session):

Sharon will contact you after approximately 12 weeks when your relative/friend is starting step 4 of their part inthestudy tocomplete the same questionnaire aboutyour relatives communication and mood. Again you can complete these questionnaires over the phone orin person whatever is best for you. It should take no more than 45 minutes for you to do these

Step 4 (1 session)

After a further 12 week break Sharon will contact you one final time to complete the same two questionnaires. Again you can complete these in person or over the phone. Once you have done this, this will be the end of the research project for your relative/friend.

Do I have to take part?

No participation is completely voluntary, It is your choice whether or not to take part. If you agree then you will sign a consent form. However you will be free to stop taking part at any time.

What are the possible benefits of taking part?

Taking part will enable your relative/friend to take part in this study. They need a willing relatgive/friend to also participate in the study.

We can not guaranbtee that the treatment given will improve your relative/friends communication and/or interaction. However you may find answering questions about their communication and mood helpful. Answering such questions may help you understand their difficulties and recognise any changes in them.

There are no risks to taking part.
Taking part does not affect your healthcare or access to future therapy.
However your family or friend with aphasia will not be able to do any other speech and language therapy whilst being part of this project.

Some people may find answering questions about the relative/friends' communication and mood sensitive, embarrassing or distressing. Sharon researcher is a trained and experienced SLT who routinely works relatives/friends of people with global aphasia. She will be able to support you to work through your feelings and issues. However if you remain upset, Sharon will ask permission to contact your G.P.

What happens when the research project stops?

When the study ends your relative/friend's therapy also ends. They will not receive any more treatment from the study and you will not need to answer any more questions related to you're their involvement.

What if there is a problem?

Any complaint about the way your relative/friend has been dealt with during the study or any possible harm they might suffer will be addressed. The detailed information on this is given in Part 2.

Will my participation of be kept confidential?

Yes. Ethical and legal practice will be followed. All information about you will be handled in confidence. The details are included in Part 2.

This is the end of Part 1.

If the information in Part 1 has interested you and you are considering the participation of your relative/friend, please read the additional information in Part 2 before making any decision.

PART 2: ADDITIONAL INFORMATION ABOUT THE RESEARCH PROJECT

What will happen if I don't want to carry on with the study?

If you stop taking part the questionnaires you have completed with Sharon up to that point will be kept. Stopping the study will have no impact on your relative/friends current or future care.

What if there is a problem or something goes wrong?

If you have a concern about any aspect of the study you should contact Sharon's supervisor and the chief investigator of this study **Dr Suzanne Beeke** on 020 7679 4215 or email s.beeke@ucl.ac.uk.

If you are still unhappy and wish to complain, UCL complaints mechanisms are available to you. You can write to:

Mr David Wilson,
Joint Research Office
University College London
1stFloor, Maple House
Suite B
149 Tottenham Court Road
London W1T 7DN

Will my participation be kept confidential?

Yes. All information about you will be kept strictly confidential. We will follow the rules of the Data Protection Act 1998. Your name, address and telephone number will be kept on an encrypted hard-drive at UCL, which only Sharon Adjei can access using a password. This information will be destroyed as soon as you complete thestudy. Authorised people from UCL may look at information we collect about you to check that the study is being carried out correctly. All will have a duty of confidentiality to you.

What if relevant new information becomes available?

It is unlikely that new information would emerge during the study that would be relevant to your continued participation. However, should this scenario arise, the researcher will inform you by telephone and also write to you to inform you of this new information.

Involvement of the General Practitioner/Family Doctor (GP)

We will **no**t need to inform your GP that they taking part in the study. However if a health issue arises e.g. persistent distress from answering the questionnaires Sharon may ask your permission to contact your GP..

What will happen to the results of the research study?

The results of this research will be written up for Sharon's doctorate award and for publication in peer reviewed scientific journals. Sharon will also make the results available to the aphasia community via the paper/online publications of the following user groups: Stroke Association , Different Strokes, Speakability and British Aphasiology Socitety. The results may also be verbally presented at conferences but you and your relative/friend will be given a false name in anything we write or present about them. When we write and talk about the research, we will use your false names not your real names. You will receive a summary document of the findings

How have patients and public been involved in this study?

Relatives and friends of other people with global aphasia have been consulted about this study.

Who is organising and funding the research?

University College London is sponsoring and organising the research. Neither Sharon or the Speech and Language Therapist who referred your relative/friend for this study are being paid to be involved.

Who has reviewed the study?

All research in the NHS is looked at by independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by _____________Research Ethics Committee.

Further information and contact details

1) For General Information about Research:

INVOLVE is an organisation that supports user participation in research. Find out more about getting involved in research in general **either** via their website: http://www.invo.org.uk/find-out-more/getting-involved/ or phone: **023 8065 1088.**

2) For Specific Information about this research

Contact Sharon Adjei on [redacted] or email her at s.adjei.12@ucl.ac.uk

3) For Advice as to whether or not you should participate

Contact Sharon Adjei (details above)

4. If you are unhappy with the study

Initially contact Dr Suzanne Beeke on 020 7679 4215 or email s.beeke@ucl.ac.uk

Alternatively, you can write and make a formal complaint to:
Mr David Wilson,
Joint Research Office
University College London
1stFloor, Maple House
Suite B
149 Tottenham Court Road
London
W1T 7DN

Full contact details

Project Supervisor
Dr Suzanne Beeke
Chandler House
2 Wakefield Street
London
WC1N 1PF
Tel 020 7679 4215

Email s.beeke@ucl.ac.uk

9.9 Appendix 9 Consultee declaration form

RESEARCH DEPARTMENT OF LANGUAGE AND COMMUNICATION
University College London
Chandler House,
2 Wakefield Street,
London WC1N 1PF

CONSULTEE DECLARATION FORM

Study Number:

Participant Identification Number:

Title of Project: **An Investigation into the effect of a novel, non-verbal cognitive treatment on functional Communication in global aphasia. (Student Study)**

Name of Researcher: **Suzanne Beeke**

Name of Student: Sharon Adjei

Please initial all boxes

1. I__________________have agreed to be consulted about____________________________'s participation in the above research project. ☐

2. I have read the consultee information sheet dated 16.08.14 (version 2), for the above study. I have had the opportunity to ask questions about the study and understand what is involved. ☐

3. I understand that__________________________'s participation is voluntary and I can request he/she is withdrawn from the study at any time without giving any reason and without his/her care or legal rights being affected. I understand that any data collected from them up to this point will be kept. ☐

4. I understand that relevant sections of his/her medical records and data collected during the study may be looked at by responsible individuals from within the Division of Psychology and Language Sciences, University College London, from regulatory authorities or from the NHS trust where it is relevant to their taking part in this research. I give permission for these individuals to have access to the records of ☐

____

5. I agree to their GP being informed of their participation in the study. ☐

6. I agree to their care/medical records being accessed if necessary by Sharon Adjei. ☐

7. I agree to_______________being video recorded interacting with the researcher and carrying out tasks during the study. I understand that their face can not be hidden on these recordings. ☐

9.10 Appendix 10 Consent form for relatives/friends of PwGA

RESEARCH DEPARTMENT OF LANGUAGE AND COMMUNICATION
University College London
Chandler House,
2 Wakefield Street,
London WC1N 1PF

CONSENT FORM

Study Number:

Participant Identification Number:

Title of Project: **An Investigation into the effect of a novel, non-verbal cognitive treatment on functional Communication in global aphasia. (Student Study)**

Name of Researcher: **Suzanne Beeke**

Name of Student: Sharon Adjei

Please initial box

1. I confirm that I have read the participant information sheet dated 30.05.14 (version. 1.0) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected. ☐

3. I understand that relevant data collected during the study, may be looked at by responsible individuals from within the Division of Psychology and Language Sciences, University College London, from regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

4. I agree to take part in the above study. ☐

________________	________________	________________
Name of Participant	Date	Signature
________________	________________	________________
Name of Person taking consent	Date	Signature

9.11 Appendix 11Collaborator information sheet

RESEARCH DEPARTMENT OF LANGUAGE AND COMMUNICATION
University College London
Chandler House,
2 Wakefield Street,
London WC1N 1PF

INFORMATION FOR PARTICIPANT IDENTIFICATION CENTRES /SLT COLLABORATORS

Research Title:
An investigation into the effect of a novel non-verbal cognitive treatment on functional communication in global aphasia (Student study)

Study Number 13/0581 **Chief Investigator Dr Suzanne Beeke Doctorate Student Sharon Adjei**

Thank you for your interest in the above research study which has been approved by the National Research Ethics Service (NRES) (see attached ethical approval letter). It is hoped that your site will be able to identify a participant to take part. This information summarises the study but more detailed information can also be found in Research Protocol (attached).

Summaryof Study

This study aims to improve the functional communication of clients with severe communication difficulties post stroke (global aphasia). Clients will first be robustly assessed over a six week period before trialling a new treatment which will focus on their underlying cognitive difficulties. The treatment involves non-verbal cognitive tasks designed by the researcher that focus on visual and auditory perception, non-verbal semantics and non-verbal problem solving. The treatment is offered 2-3 times a week for up to 6 weeks (depending on clients tolerance and performance). Treatment sessions are video-recorded to aid analysis. It is hypothesised that the treatment will improve the client's ability to initiate calling for help, share a joint term of reference, make a basic choice, understand gestures, recognise/use objects and use pointing to communicate. After the treatment programme has been completed, the client is re-assessed over a 2 week period and then followed up in 3 months.

Who am I looking for?

Adult clients who have

- had one or more strokes (as diagnosed by a physician) of which the most recent was at least 6 months ago
- global aphasia as diagnosed by an SLT i.e. have
  - -little to no verbal output
  - -inconsistent single word comprehension
  - -little to no ability to read or write
  - -little to no ability to use alternative modes of communication
  - -little to no ability to make choices in function
- no diagnosis/history of a progressive neurological condition
- no diagnosis of hearing loss
- no diagnosis/history of a mental health condition.
- Pre-morbidly fluent in English language

What is involved for participants?

Pre-treatment Testing (Step 1)	Treatment (Step 2)	Post Treatment Testing (Step 3)	Follow Up (Step 4)
Twelve sessions of assessments over approximately 6 weeks	Three times a week for up to 6 weeks depending on performance	Six sessions over a 2 week period	12 week rest period 3 follow up sessions

All sessions are expected to last for 45 minutes but will be tailored to the needs and tolerance of the individual.

Participants should not be receiving any other speech and language intervention during the active time taking part in the study (ie steps 1-3)

The participant's GP will be informed of their participation in the study.

What is involved for the participants' significant other?

The participant must have a carer/relative or friend who is willing to consent on their behalf. This person is known as a consultee and is also required to liaise with the researcher in person or by phone about the participant's communication skills and general mood on three occasions during the course of the study. The consultee receives a "consultee information sheet" with detailed information about the study and their role (see attached) before later completing a "consultee declaration form" which forms the consent for the study. (see attached)

What if we are able to identify a participant at this site?

Sharon will liaise with the client's next of kin regarding acting as consultee. If they are willing for their loved one to take part permission is required from the Research & Development Co-ordinator if you are an NHS site or a senior manager if you are a non-NHS site.

Thank you for reading this information. We hope that you can support this study.

Please do not hesitate to contact **Sharon Adjei (SLT/Doctoral student) Tel**: [redacted]
Email: s.adjei.12@ucl.ac.uk if you require any further information.

9.12 Appendix 12 Letter of invitation

SLT Collaborator Service Logo, Service Name and Address

Date____________________

LETTER OF INVITIATION TO PARTICPATE IN A RESEARCH STUDY

Dear Next of Kin / Carer of ______________________________

I feel______________________may be suitable to take part in a research project being run at **University College London** by **Dr Suzanne Beeke** (Chief Investigator) and **Sharon Adjei** (a speech and language therapist and research student).

The study is called:

AN INVESTIGATION INTO THE EFFECT OF A NOVEL, NON-VERBAL, COGNITIVE TREATMENT ON FUNCTIONAL COMMUNICATION IN GLOBAL APHASIA (Student Study)

Study Number 13/0581

The study is for people like your relative/friend who have global aphasia i.e. find it difficult to interact, understand, speak, read, write or use alternative forms of communication like pointing, gesture or pictures after they have had a stroke.

There have been very few research studies that have looked at speech and language therapy for people with global aphasia. In fact most research excludes people with global aphasia. This research is specifically designed for people with global aphasia and will see whether a new therapy programme can help your relative/friend interact and communicate better.

Because your relative/friend has communication difficulties you or another relative/friend will need to act as a consultee i.e. advise us as to whether you think they would want to participate in the study. You or another relative/friend will also need take part in some parts of the study. There is more detailed information about the study in the enclosed **information sheets for you** entitled "**Information for Potential Consultee's"** and "**Information for Friends and Relatives of People with Global Aphasia".** Please read these carefully and consider whether you are interested. Enclosed is also an **information sheet for your relative/friend** entitled "**Participant Information Sheet".** However, I understand that your relative / friend will be unlikely to be able to understand the information.

If you are interested in your relative / friend taking part. Sharon would like to visit you and your relative/friend to answer any questions you may have and assess their current communication abilities and suitability for the study.

If you would like Sharon to visit you, please contact her by telephone on [redacted]**6** or by email s.adjei.12@ucl.ac.uk or by returning the slip below directly to her at the address specified within ONE MONTH of receiving this letter .

Thank you for reading this information

Yours Sincerely

collaborating SLT signature and name]

REPLY SLIP

Your Relative/Friends Name: ______________________________

Your relationship to them: ______________________________

Your name: ______________________________

Your telephone number: ______________________________

I have read the BOTH the "Information in the Information for Potential Consultee's" sheet AND the "Information for Friends and Relatives of People with Global Aphasia"

(please tick) ☐

I believe my relative/friend would want to be considered for this research and I am happy for Sharon Adjei to contact me to arrange a visit and discuss this further.

(please tick) ☐

Signed

____

Please return this slip to:

Sharon Adjei
UCL DCCS Student
Room 202
Chandler House
2 Wakefield Street
London
WC1N 2PF

9.13 Appendix 13 List of communication behaviours assessed within ASHA-FACS

Social communication

1. refers to familiar people by name
2. requests information of others
3. explains how to do something
4. expresses agreement/disagreement
5. exchanges information on the phone
6. participates in group conversation
7. answers yes/no questions
8. follows simple directions
9. understands intent
10. smiles or laughs at light-hearted comments
11. understands non-literal meaning and inference
12. understands conversations in noisy/distracting situations
13. understands what is heard on tv or radio
14. understands facial expressions
15. understands tone of voice
16. initiates communication with others
17. adds new information on a topic in a conversation
18. changes topic in conversation
19. adjusts to change in topic by conversational partner
20. recognises his/her own communication errors
21. corrects his/her own communication errors

Communication of basic needs

22. recognises familiar faces
23. recognises familiar voices
24. makes strong likes/dislikes known
25. expresses feelings
26. requests help when necessary
27. makes needs or wants known
28. responds in an emergency

Reading, writing, number concepts

29. understands simple signs
30. uses common reference materials
31. follows written directions
32. understands basic printed material
33. prints/writes/types name
34. fills out short forms
35. writes messages
36. understands signs with numbers
37. makes basic money transactions
38. understands simple units of measurement

Daily planning

39. knows what time it is
40. dials telephone numbers
41. keeps scheduled appointments
42. uses a calendar for time related activities
43. follows a map

9.14 Appendix 14 Qualitative communication definitions for each dimension within ASHA-FACS

	Adequacy	Appropriateness	Promptness	Communication Sharing
5	Client always understands the gist of message and always gets point across.	Communication is always relevant and is always done under the right circumstances.	Communication is always without delay and always efficient.	Client and partner share equally in communication.
4	Client often understands gist of message often gets point across.	Communication is often relevant and is often done under the right circumstances.	Communication is often without delay and often efficient.	Partner carries little more than half of the communication burden.
3	Client understands gist of message and gets point across about half of the time.	Communication is relevant and done under the right circumstances about half of the time.	Communication is without delay and efficient about half of the time.	Partner carries well over half of the communication burden.
2	Client seldom understands gist of message and seldom gets point across.	Communication is seldom relevant and is seldom done under the right circumstances.	Communication is seldom without delay and seldom efficient.	Partner carries almost all of the communication burden.
1	Client never understands gist of message and never gets point across.	Communication is never relevant and is never done under the right circumstances.	Communication is never without delay and never efficient	Partner carries all the communication burden.

9.15 Appendix 15 Raw results for each communication independence behaviour on ASHA-FACS for all participants

Social communication

CI behaviour	Bernard			Pete			Alan			Ruby			Henry			Kevin		
	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	3	1	4	1	1	1
3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	2	4	3	6	4	5	2	2	4	1	1	1	4	7	7	2	3	3
5	1	1	1	1	3	1	1	1	3	1	1	1	1	1	1	1	1	1
6	1	2	1	1	1	2	1	2	3	1	1	1	1	3	3	1	1	1
7	4	7	3	4	6	5	3	2	5	1	1	1	4	5	7	2	4	5
8	3	5	4	2	6	5	2	4	5	1	1	1	3	5	6	2	2	4
9	5	3	2	6	5	3	1	2	3	1	1	1	3	5	6	2	3	2
10	5	2	4	6	5	3	3	1	2	2	2	2	3	7	7	3	2	2
11	1	1	2	N	4	2	3	2	1	1	1	1	2	2	1	3	2	4
12	2	2	3	2	2	3	2	4	4	1	1	1	3	2	4	2	2	3
13	3	7	4	5	1	2	4	2	4	1	1	1	3	6	6	2	2	2
14	3	5	5	5	4	6	6	5	6	3	1	2	5	7	7	5	5	6
15	3	7	5	5	4	5	6	5	5	N	1	1	4	7	7	4	5	3
16	2	7	5	2	5	6	1	4	4	2	1	1	1	1	2	1	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1
18	1	1	1	N	1	1	1	1	1	1	1	1	2	3	1	1	1	1
19	1	1	2	1	1	2	1	3	3	1	1	1	3	4	6	2	2	1
20	1	4	5	1	1	4	6	4	5	1	1	1	5	7	7	1	4	2
21	1	1	1	1	1	1	1	1	1	1	1	1	2	6	6	1	1	1

N=no basis for rating. B=baseline P= post intervention M =maintenance

Communication of basic needs

CI

Behaviour	Bernard			Peter			Alan			Ruby			Henry			Kevin		
	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M
22	7	7	7	6	6	7	7	7	7	7	2	2	7	7	7	7	7	7
23	5	7	5	5	6	7	5	7	5	N	1	1	N	N	N	N	N	2
24	3	7	5	6	7	6	3	7	5	1	1	1	6	7	7	4	6	5
25	2	7	4	5	4	4	2	7	4	2	1	1	4	5	7	2	4	3
26	3	5	6	5	7	7	3	5	6	1	1	1	2	4	7	4	6	4
27	2	7	7	5	7	7	2	7	7	1	1	1	2	6	7	2	4	3
28	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1

N=no basis for rating. B=baseline P= post intervention M =maintenance

Reading, writing and number concepts

CI

Behaviour	Bernard			Peter			Alan			Ruby			Henry			Kevin		
	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M
29	N	1	1	N	1	1	N	1	1	1	1	1	3	5	7	N	N	1
30	1	1	1	1	1	1	1	1	1	1	1	1	2	7	7	1	1	1
31	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	N	1
32	1	2	1	1	3	1	1	2	1	1	1	1	4	5	6	2	3	1
33	6	7	7	1	1	1	6	7	7	1	1	1	3	1	2	1	1	1
34	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
35	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
36	N	N	N	1	N	1	N	N	N	1	1	1	3	5	6	1	1	1
37	1	1	1	1	N	1	1	1	1	1	1	1	1	6	6	1	N	1
38	N	1	N	1	1	1	N	1	N	1	1	1	2	1	N	N	1	1

N=no basis for rating. B=baseline P= post intervention M =maintenance

Results for daily planning on ASHA-FACS for all participants

CI Behaviour	Bernard			Peter			Alan			Ruby			Henry			Kevin		
	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M
39	4	4	5	1	4	3	4	4	5	1	1	1	1	7	7	2	2	2
40	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1
41	N	1	1	1	N	1	N	1	1	1	1	1	1	1	6	1	1	1
42	1	1	1	1	1	2	1	1	1	1	1	1	2	N	5	1	2	1
43	1	N	1	N	N	1	1	N	1	1	1	1	2	N	7	1	1	1

N=no basis for rating. B=baseline P= post intervention M =maintenance

9.16 Appendix 16 Raw results for ASHA-FACS qualitative communication dimensions for all participants

QC Behaviour	Bernard			Peter			Alan			Ruby			Henry			Kevin		
	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M
Adequacy																		
Social communication	3	3	3	3	3	3	2	3	4	2	2	2	3	4	3	2	3	4
Communication of basic needs	3	4	4	4	4	4	2	4	4	1	1	1	3	4	4	3	4	4
Reading, writing, number	2	2	2	1	1	1	1	2	1	1	1	1	2	3	3	1	2	1
Daily planning	2	1	2	2	1	2	2	1	1	1	1	1	2	4	4	1	2	1
Appropriateness																		
Social communication	3	3	4	3	3	4	2	4	4	1	1	1	3	4	4	3	3	4
Communication of basic needs	3	4	4	4	4	4	2	4	4	1	1	1	2	4	5	3	4	4
Reading, writing, number	2	2	2	1	1	1	1	2	2	1	1	1	2	3	3	1	2	1
Daily planning	1	1	2	1	2	2	1	1	1	1	1	1	1	3	4	1	1	1
Promptness																		
Social communication	3	3	3	2	3	3	2	4	4	1	1	1	3	4	4	3	3	4
Communication of basic needs	3	4	4	4	4	4	2	4	4	1	1	1	2	3	4	2	3	3
Reading, writing, number	1	2	2	1	1	1	1	2	2	1	1	1	2	2	2	1	2	1
Daily planning	1	1	2	1	1	1	1	1	1	1	1	1	1	2	3	1	1	1

	Communication sharing																	
Social communication	2	3	3	2	2	2	1	3	3	1	1	1	2	3	3	3	3	2
Communication of basic needs	3	3	4	3	3	3	2	3	2	1	1	1	2	3	4	2	3	3
Reading, writing, number	[redacted]																	
Daily planning																		

B=baseline P= post intervention M =maintenance

9.17 Appendix 17 Raw results from INTERPReT results for all participants

INTERPReT Behaviour		Bernard			Peter			Alan			Ruby			Henry			Kevin		
		B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M
Acknowledges SLT at start of interaction	S 1	5	0	5	0	0	0	5	5	5	0	5	5	5	5	5	5	5	0
	S2	5	0	0	0	0	0	5	5	5	5	0	0	5	5	5	0	0	0
	S3	0	0	0	0	0	0	5	5	5	0	0	0	5	5	5	5	0	5
Able to make choice from 2 activities	S1	3	5	3	5	5	4	5	5	5	4	4	4	5	5	5	5	5	5
	S2	5	4	5	4	5	0	5	5	5	2	0	0	5	5	5	5	5	5
	S3	4	4	4	5	5	5	4	4	4	5	2	2	5	5	5	5	5	5
Able to answer a Yes/No question	S1	5	5	5	5	5	5	5	5	5	3	3	0	4	5	5	5	5	5
	S2	5	5	5	5	5	5	5	5	5	0	0	0	5	5	5	5	5	5
	S3	5	5	5	5	5	5	2	5	5	3	3	3	5	5	5	5	5	5
Shares joint focus with SLT	S1	5	5	5	5	5	5	5	5	5	5	4	0	5	5	5	5	5	4
	S2	5	5	5	5	5	5	5	5	5	3	3	2	5	5	5	5	4	5
	S3	5	5	5	5	5	5	4	4	4	3	3	2	5	5	5	5	5	5

		Bernard			Peter			Alan			Ruby			Henry			Kevin		
INTERPReT Behaviour		B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M
Attempts to initiate communication																			
	S1	5	5	5	0	5	5	5	5	5	0	0	0	5	5	5	5	0	0
	S2	0	5	0	0	5	0	5	5	5	0	0	0	5	5	5	0	0	5
	S3	0	0	0	0	5	0	0	5	5	0	0	0	5	5	5	0	0	5
Demonstrates general understanding of task	S1	5	5	5	5	5	5	5	5	5	0	3	3	5	5	5	5	5	5
	S2	5	5	5	5	5	5	5	5	5	3	3	3	5	5	5	4	5	5
	S3	5	5	5	5	5	5	5	5	5	3	3	2	5	5	5	5	5	5
Demonstrates specific understanding of task +/- rules	S1	3	5	5	5	5	4	5	5	5	2	3	0	4	5	5	3	5	2
	S2	3	5	4	5	5	5	3	5	5	0	0	0	5	5	5	0	0	5
	S3	3	5	0	3	5	2	5	5	5	2	2	0	5	5	5	4	5	5
Notices noise in background																			
	S1	5	5	5	5	5	5	5	5	5	5	5	0	4	5	3	4	5	2
	S2	2	5	5	5	5	5	3	5	5	0	0	0	2	5	5	0	0	5
	S3	3	2	0	0	5	0	2	4	4	5	0	0	5	5	5	3	0	0

INTERPReT Behaviour		Bernard			Peter			Alan			Ruby			Henry			Kevin		
		B	P	M	B	P	M	B	P	M	B	P	M	B	P	M	B	P	M
Able to continue despite noise interruption	S1	5	5	5	5	5	5	4	5	5	4	4	3	5	5	5	5	5	5
	S2	5	5	5	5	5	5	5	5	5	4	3	3	2	5	4	5	5	5
	S3	5	5	5	5	4	5	3	4	4	3	3	2	5	5	5	5	5	5
Shows awareness of problem within the activity	S1	5	2	5	5	4	4	5	5	5	2	0	0	5	5	5	0	5	0
	S2	5	2	4	2	5	5	4	4	5	0	0	0	5	5	5	5	5	0
	S3	0	2	5	0	0	0	5	5	5	3	0	0	5	5	5	0	3	5
Able to rectify the problem	S1	0	0	5	5	5	4	5	5	5	1	0	0	5	5	5	0	5	0
	S2	5	2	4	5	5	5	4	5	5	0	0	0	5	5	5	5	5	0
	S3	0	2	4	0	0	0	4	5	5	0	0	0	5	5	5	0	3	5

B= baseline P= post intervention M= maintenance