Assessing the benefits of multimodal rehabilitation therapy for aphasia

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Abstract

Background: Parallel Distributed Processing (PDP) is a form of computation where a large number of processing units performing simple calculations can be employed together to solve complex problems. PDP modelling suggests that efficiency on multiple task problems may be critically related to the economy of the representations that are developed to support those tasks. One area where this observation is likely to be crucial is language, where a number of related linguistic tasks (speech, comprehension, repetition and reading) may be supported by the same set of representations. This could be important in therapy where representations have to be re-learned. This clinical study examines whether elicitation of a word in multiple modalities maximises the degree of relearning.

Aims: (1) to determine the relative effects upon naming of an multimodal Item Focused therapy compared to a unimodal Task Focused therapy; (2) to determine the effects both therapies upon naming immediately and at one-month after therapy; and (3) to examine the effects of the two therapies on non-targeted language tasks (repetition, spelling to dictation and reading aloud).

Methods & Procedures: 8 English speakers with aphasia 6 months post-stroke, with moderate-severe word-finding difficulties and phonological errors in speech were recruited. Linguistic and cognitive assessments were performed with each participant prior to therapy. A cross-over design was employed with each participant receiving the therapies in 2 x 2 week blocks (10 x 60 minute daily sessions within each block: 9 therapy sessions and 1 immediate post-therapy assessment session). A follow-up assessment session was carried out 4 weeks after the final therapy session in each block. The Item Focused therapy comprised: spoken word-to-picture match; spoken word-to-written match; ‘Yes’/’No’ semantic questioning; semantic feature analysis, naming; spelling rearrangement and repetition. The Task Focused
therapy comprised a picture naming task using an increasing semantic, phonological and orthographic cue hierarchy until identification.

**Outcomes & Results:** Both therapies were found to improve the naming abilities of all participants in the short-term, and with maintenance effects for 5 of the 6 participants after one month. Whilst Item Focused therapy results for naming and the additional tasks showed some effectiveness compared to the Task Focused therapy, it is not possible to state conclusively that the Item Focused therapy is the more effective.

**Conclusions:** The results validate providing impairment based naming therapy for those with a range of deficits at different time points in recovery. Despite results being limited by the power of the study, they are promising enough to warrant continued investigation into Item Focused therapy promoting greater Representational Economy. Additionally, the results hint at the value of examining language profiles more closely i.e. levels and domains of impairments, to determine likelihood of immediate and maintained response to therapy.
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Chapter 1

An Introduction

1.1 Motivation

Impairment-based therapies intend to directly modify aspects of an individual’s impaired language, in order to reduce the disability associated with aphasia, thereby promoting increased participation (RCSLT, 2001). Impairment-based therapies should be grounded on an explicit theoretical foundation and one such theoretical framework frequently applied is cognitive neuropsychology (CN). CN is the study of patterns of impaired and preserved ability in those with brain damage in an attempt to infer theories of typical cognitive structure and function. Aphasia clinicians are motivated to apply CN as analysis of typical performance is expected to inform recovery and rehabilitation of impairments. CN is a useful clinical framework as approaches to therapy depend on conceptualising processes and the recovery of such processes (Harley, 1996).

The traditional CN model types clinically applied are ‘box and arrow’ information processing models (e.g. Ellis & Young, 1988; Kay et al., 1992). These models propose sets of discrete components which are assigned a specific function with resultant assumptions i.e. modularity (relatively autonomous components responsible for a process which make a contribution to the system as a whole) and seriality (serial, step wise processing) (Davies, 2010). Box and arrow models have undoubtedly been successfully implemented in devising assessment, as they are able to identify what is impaired. Yet, their therapeutic application has struggled to address how to target the identified impairment. Therapy based on ‘box and arrow’ theorising assumes discrete boxes and arrows can be targeted with the intention of producing relatively independent effects upon dedicated mechanisms, rather than an interactive effect upon the whole language system. It has therefore been suggested that these models are only, at best, an
outline as they are underspecified for representations and processing mechanisms (Davies, 2010). Alternative CN models, however, have been developed that attempt to make explicit the representations and mechanisms for a given performance. Multi-system, connectionist theories of language processing e.g. Primary Systems Hypothesis (Patterson & Lambon Ralph, 1999), suggest that all language tasks are underpinned by three core systems (semantics, phonology and orthography/vision) with the same sets of representations underpinning all multimodal language tasks. Such models imply that performance in a given task e.g. naming, will be reflected across other language tasks e.g. reading, comprehension or writing. Similarly, the effects of therapy may not be so discrete with potential cross-modality / system effects.

The principles underlying these alternative theories are connectionist in nature. Connectionism suggests that processing is carried out by a network of processing units operating in parallel by sending continuous activation through weighted connections (Dell & Caramazza, 2008). An important distinction within a connectionist network is whether the representations (patterns of activation) are localised (i.e. where an abstract unit exists for a concept) or distributed (i.e. where many units are involved). The alternative theories mentioned early (e.g. PSH) assume representations are distributed and processes take place in parallel across the distributed representations (McLeod, Plunkett & Rolls, 1998) giving rise to the term parallel distributed processing (PDP) models. In such PDP models, large numbers of interconnected neuron-like units (e.g. semantics, phonology and orthography) can be represented by sets of units with each unit being involved in the representation of a number of words. Between the units are adjustable connections modified by learning, typically through back propagation, where the patterns of activations generated in response to an input are influenced to change towards a greater level of accuracy. It is in the strength of these connections that the knowledge of the network is represented. Once performance has been
developed, certain connections and / or units can be removed, in effect ‘lesioning’ the network that can then attempt recovery through relearning patterns of activation.

As PDP models use neural-like processing in an attempt to specify a neurally plausible mechanism for a given performance (i.e. what goes on inside the boxes), they naturally lend themselves to computational modelling - a technique involving calculations of behavioural performance, in a given context, which are simulated via a computer programme (Gupta, 2008). Computational cognitive neuropsychology has emerged as an effective framework for interpreting neuropsychological data (Dell & Caramazza, 2008). The technique requires highly specified theories of processing, such as PDP, in order to simulate neuropsychological processes in the attempt to make explicit representational and processing assumptions (Harley, 2004). A number of computational PDP models have successfully simulated typical and impaired cognitive behaviours in a number of domains including semantics (Plaut, 2002; Rogers, Lambon Ralph, Garrad, Bozeat, McClelland & Hodges, 2004; Dilkina, McClelland & Plaut, 2008); past tense generation (Jonaisse & Seidenberg, 1999) and word reading (Seidenberg & McClelland, 1989; Plaut, 1996; Harm & Seidenberg, 2004; Welbourne & Lambon Ralph, 2006). The nature of recovery and relearning of language skills, however, has received only limited attention (e.g. Plaut, 1996; Welbourne & Lambon Ralph, 2005; Welbourne & Lambon Ralph, 2007). This is despite the potential contribution of the approach to aphasia therapy stemming from the inherent capability of PDP models to learn (Welbourne & Lambon Ralph, 2005). The clinical significance of PDP computational modelling is therefore demonstrating which processes are impaired but also how these impaired processes can be targeted in therapy.

1.2. **Purpose of the Thesis**
The aim of this study is to contribute to the research combining PDP computational modelling of language processing and aphasia recovery/rehabilitation. The research forms part of a wider research effort to understand how the brain supports language function, how this breaks down after brain damage and the mechanisms that support recovery/rehabilitation. The current study focuses on the clinical portion of the research and is linked to a PhD project, which is concerned with the computational modelling of recovery/rehabilitation.

Computational networks are capable of generating predictions regarding recovery and rehabilitation of task performances thereby addressing specific clinical issues. One such issue is whether elicitation of a word in multiple modalities maximises the degree of relearning. Determining the effect of cross-modal input and output upon anomia and other language tasks would be of substantial benefit, given that aphasia is a multimodal language impairment. PDP modelling is capable of addressing and offering an explanation as to the mechanism underpinning multimodal therapy. The PDP modelling research suggests that large numbers of processing units used in the completion of simple tasks can be combined to solve more complex tasks, such as language processing (McLeod et al., 1998). This principle may be crucial for language performance where a number of language tasks (e.g. speech, understanding and reading) may be supported by the same set of representations. If, for example, the representations that support spoken comprehension are similar to those used to support reading, then a computational model would be expected to perform well at simulating the behaviours. However, if the model uses different representations to support both these tasks it may be less efficient at both. Efficiency may be critically related to the similarity in the patterns of activations that support those complex tasks, a concept known as Representational Economy. Representational economy may be critical for therapy where the intention is to promote the most effective relearning of representations. The concept proposes an account for why multimodal therapy might be more effective, as training to restore
representational economy may restore the intermediate set of representations possible of generating responses in all modalities\(^1\). Therapy maximising economic representation would encourage the use of the same sets of representations for a range of language tasks across different modalities. Such therapy would involve the completion of a range of tasks that provide multiple modality inputs and expect multiple modality outputs for a single item in turn – an item focused therapy. In comparison, therapy minimising economic representation may generate task specific representations encouraging different sets of representations for a specific language task in a given modality – a task focused therapy. With an item focused therapy intending to encourage use of the same sets of representations for a range of language tasks, it can be argued that it may promote greater retention of learnt items. Whilst immediate learning of items post-therapy is frequent, maintaining the effect is often problematic (Tuomiranta, Grönholm-Nyman, Kohen, Rautakoski, Laine & Martin, 2011). New word learning requires encoding of the phonological and semantic characteristics for the word, consolidation and storing of the information in long-term memory, and retrieval when the word is to be used (Tuomiranta et al., 2011). Repeatedly strengthening the same representations and connections to be used across several language tasks via a multimodal approach may result in greater maintenance of learnt items when compared to a unimodal approach which potentially requires the generation of several sets of representations. An experimental study is warranted to investigate whether a multimodal therapy may be more effective in the rehabilitation of anomia, and other impaired language tasks.

1.3. **Overview of Thesis**

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\(^1\) The computational testing of representational economy is being conducted as part of another PhD project funded by the same grant as this current project
The potential contribution of PDP computational modelling to anomia rehabilitation is examined in the literature review in Chapter 2. The primary aims of the review are to examine, firstly, if and how PDP computational models are used as a reference for therapy and, secondly, to determine the extent of multimodal anomia therapy in the literature from 2000. Chapter 3 provides an account of the methodology for the study. All language and cognitive assessments are described in detail, as are the 2 types of therapy presented in the study – Item Focused (multimodal) and Task Focused (unimodal). The profiles of participants are discussed in Chapter 4. Results of all therapy outcome measures are presented in Chapter 5 with a discussion of findings in Chapter 6. Limitations of the study, clinical implications and future directions are also considered in the final section.
Chapter 2

Literature Review: Does Cognitive Neuropsychology have a role in aphasia rehabilitation?

2.1 Introduction

For aphasia therapies intending to promote the relearning of impaired language skills, cognitive neuropsychology is a common theoretical framework underpinning treatment. Cognitive neuropsychology (CN) appears well suited to provide a basis for therapy design as the approach makes inferences about typical cognitive function from evidence provided by patterns of impaired performance (Patterson & Plaut, 2009). Clinical motivation to use the approach stems from the thinking that understanding typical language processing ought to support the design of effective therapies intending to remediate impaired language processing (Plaut, 1996).

The influence of the approach upon rehabilitation has not, however, been spared comment. In 2000, Neuropsychological Rehabilitation dedicated a special edition to considering the role of CN in aphasia rehabilitation. Overall, the tone of the papers was not optimistic. Basso and Marangolo (2000) directly addressed the question of whether treatment can be guided by cognitive theory. The authors were rather skeptical. Positively they concurred that therapy grounded in assumed knowledge of cognitive structures and processing enables a principled approach to therapy. Yet, CN had failed to contribute guidelines for remediation of aphasic impairments, specifically those processes that are modifiable and how intervention can redress a damaged process. They concluded emphatically ‘cognitive neuropsychology cannot guide treatment as it does not indicate what should be done in therapy or how it ought to be done’ (pg. 288). Similar opinion has been mooted more recently, but alongside possible reasoning for this viewpoint. For example, Patterson & Plaut (2009), lament CN’s apparent
lack of impact but suggest that a significant factor may be the over-reliance on descriptive box-and-arrow processing models (e.g. Ellis & Young, 1988; Kay et al., 1992).

The intention of box and arrow theorising has been to illustrate the functional architecture of cognitive processes, such as language processing. The models outline language routes by proposing sets of discrete components, which are assigned specific processes (boxes), with interrelated connections (arrows) depicting information flow (see Fig. 2.1).

![Fig. 2.1 An example of box and arrow functional architecture (Ellis & Young, 1988)](image)

Whilst ‘box and arrow’ models have undoubtedly facilitated the identification of impaired components and routes (i.e. assessment), they have struggled to address how to target identified impairments (i.e. therapy) since they are underspecified for representations and processing mechanisms. Consequently, this has led to the suggestion that methods requiring explicit specification of component representations and mechanisms might have something vital to offer (Plaut and Patterson, 2009).
Computational modelling is a technique attempting to make explicit representational and processing assumptions. It enables the investigation of complex parallel processing systems through a computer programme, instantiating a specific theory, intending to perform a task akin to human performance (Caramazza & Coltheart, 2006). The tool has been used within cognitive neuropsychology, an approach known as computational cognitive neuropsychology, in an attempt to investigate which processes are involved in cognitive activities such as language processing, as well as the potential underlying mechanisms by which relevant processes can be learned and relearned (Harley, 2004).

To be successful, computational models require highly specified theories. Connectionism is one such framework that consequently lends itself to computationally modelling of language processing. Connectionist principles suggest that processing is carried out by a network of processing units operating in parallel by sending continuous activation through weighted connections (Dell & Caramazza, 2008). Representations (patterns of activation that represent concepts) in a connectionist network can be localised (i.e. where an abstract unit exists for a concept) or distributed (i.e. where many units are involved). Connectionist models that assume distributed representations and processes taking place in parallel across the distributed representations are termed parallel-distributed processing (PDP) models (McLeod, Plunkett & Rolls, 1998). In PDP models, large numbers of interconnected neuron-like units (e.g. semantics, phonology and orthography) can be represented by sets of units, with each unit being involved in the representation of a number of words. Between the units are adjustable connections modified by learning, typically through back propagation, where the patterns of activations generated in response to an input are influenced to change towards a greater level of accuracy. It is in the strength of these connections that the knowledge of the network is represented (See Fig 2.2).
Once performance has been successfully captured within a PDP computational model, certain connections and / or units can be removed, in effect ‘lesioning’ the network. The network can then attempt recovery through relearning patterns of activation by altering the strength in connections between units (Plaut, 1999). It is the relearning capability of a network, which encapsulates the suitability of the approach to contribute to a theory of rehabilitation (Welbourne & Lambon Ralph, 2005). Yet, despite such promise, application of the PDP computational modelling to aphasia recovery and rehabilitation has remained somewhat unfulfilled (Welbourne & Lambon Ralph, 2005) – an unwise stance according to Harley (2004) who states that an approach focused on processes should not be ignored. PDP computational modelling is therefore well placed to address clinical issues. The approach can directly guide therapy design from the results of hypotheses tested in simulations with the generation of predictions indicating how impaired processes can be targeted in order to promote the most effective rehabilitation of impairments such as anomia.

Anomia results from damage to semantics, phonology and / or the interaction between these two domains (Lambon Ralph, Sage & Roberts, 2000). The research has long debated the relative benefits of semantic and phonological therapy, with varying application of CN models. Therapy approaches have tended to provide either a series of phonological and / or semantic tasks in the absence of a corresponding impairment, or, a corresponding approach
aiming to improve disrupted semantic and/or phonological processing (Nickels, 2002). PDP models imply that as performance and impairment in a given task e.g. naming, may be reflected across other language tasks e.g. reading (Plaut & Paterson, 1999) so to could the effects of therapy, with potential cross-modality/system effects. It is therefore of clinical worth and interest to examine whether a multimodal therapy informed by PDP computational modelling, which intends to target distributed representations in semantics, phonology and orthography used for all language tasks including naming, may result in more effective rehabilitation of anomia.

In light of this, the overarching intention of this review is to examine the potential contribution of PDP computational modelling to multimodal aphasia rehabilitation since the special edition of *Neuropsychological Rehabilitation*. The principal aims of this review are then, firstly, to examine if and how PDP computational models are used as a reference for therapy and, secondly, to determine the extent of multimodal therapy in the anomia literature as indicated by the PDP modelling research. An additional aim is to determine what the anomia literature says about the extent to which CN models have been able to guide assessment and treatment of anomia: the introduction of box and arrow information processing models (e.g. Ellis & Young, 1988; Kay et al., 1992) led to a linear correspondence between assessment and therapy selection, yet, the development of more PDP models has questioned the direction of the relationship e.g. treating shared sets of representations for both preserved and impaired tasks.

The review is divided into 4 sections. A review of published anomia therapies since 2000 has been carried out, extracting primary data about the modality of input and output in therapy and cognitive neuropsychological models used to explain the data. Secondary data were also extracted regarding assessment type and therapy provision, which allowed for a secondary investigation of the relationship between assessment and therapy. The methods for the review
are described in Section 1. The results from the review are then discussed in three further sections addressing the aims of the review. Section 2 examines the role of CN within aphasia therapy focusing on the degree to which PDP computational modelling has influenced anomia therapy design. Section 3 explores the relationship between assessment of anomia and consequent therapy selection. Section 4 explores how PDP models address issues of recovery and rehabilitation, including single (unimodal) and multiple task (multimodal) models. The inputs and outputs of multiple task models are then compared to the findings from the anomia literature specifically examining the degree of multimodal therapy.

2.2 Method

2.2.1 Selecting the papers

The databases Embase, PyschInfo and Ovid Medline were searched for anomia therapy studies from the year 2000 to 2010 using key search terms (anomia; naming; word finding deficits; word retrieval; lexical retrieval; aphasia therapy and word retrieval therapy). A secondary search of the references of identified articles was also used. Papers were included in the review if the main aim of the study was impairment-based treatment of anomia. Any acquired neurological event (e.g. cerebral vascular accident (CVA), head injury etc.) except dementia was allowed. Studies were required to target only single words and provide a clear outline of the therapy procedures and / or therapy tasks. A small number of studies that investigated both single word naming therapy and discourse / connected speech were included but only the single word therapy was reviewed. Studies were excluded if the nature of the therapy was not the primary research motivation, if therapies targeted the level of the sentence and above, or if the paper contained re-analysed published data already included (see Appendix 1 for excluded anomia studies). In total, 87 anomia therapy studies were
identified using the described search methods. After applying the inclusion criteria, 58 studies remained (see Appendix 2 for included anomia studies).

2.1.2. Calculating reference to cognitive neuropsychological models

Two model categories were established: connectionist and modular. The connectionist category was subdivided by the nature of representations to include ‘local’, ‘distributed’ and ‘other’ whilst the modular category was subdivided by the nature of processing into ‘2 stage lexical access’ and ‘box and arrow’. Only studies explicitly stating the influence of a cognitive neuropsychological model were included in this part of the analysis.

2.2.3. Determining the nature of a therapy

Three therapy categories were created – semantic, phonological and combined. Semantic therapy included tasks, which intended to improve word meaning e.g. semantic feature analysis, spoken word-to-picture match or semantic cueing. Phonological therapy recognised only tasks which aimed to improve word-form e.g. repetition, phonological manipulation or phonological cueing. Combinational therapy included any combination of more than one task targeting semantics, phonology and / or orthography. Each therapy received by a participant was categorised accordingly across all the studies.

2.2.4. Calculating input / output within a therapy task

The input/s and output/s for each therapy task received by each participant across the anomia studies were categorised. Input categories included picture, spoken, written, gesture and other. Outputs categories included speech, writing, gesture, semantic categorisation, phonological categorisation and other. Data were drawn from 453 applications of therapy provided to all participants, including studies that investigated one or more different therapies in a single participant.
2.2.5. Calculating assessment performance

Each study was examined to determine whether each participant had received at least one test of naming, semantics and phonology. A range of informal and formal tests were accepted for each aspect. In order to determine whether a participant was impaired for naming, semantics and/or phonology, the relevant assessments and participant scores were documented (absence of this information was also recorded). If more than one assessment was provided for each aspect, the test providing the most useful information to enable the identification of impairment was selected i.e. if the score had been reported or the assessment was standardised. Establishing whether a participant was impaired was only possible if relevant scores had been provided and the assessment used included normative data. Where this information was available, scores were compared to normative values and a participant was categorised as impaired or non-impaired on that particular skill. It should be noted, that these measure couldn’t adequately indicate the severity of the impairment, simply the presence or absence of difficulty.

2.2.6. Calculating the correspondence between assessment and therapy

In order to establish correspondence between performance at assessment and therapy, only the studies providing raw scores and normative data for the semantic and phonological assessments could be included. For each participant in the relevant studies, the presence (and absence) of a semantic and/or phonological impairment was cross-matched with the provision of either a semantic or a phonological treatment.

The findings from the review are presented and discussed in the following three sections.

2.3  Cognitive neuropsychological models: A theoretical basis for therapy
Box and arrow models (e.g. Ellis & Young, 1988; Kay et al., 1992) have long been implemented to inform aphasia therapy (Whitworth, Webster & Howard, 2005). These traditional models assume discrete representations and processes involved in dedicated mechanisms, with little interaction. Therapy based on these models assumes discrete boxes and arrows can be targeted with the intention of producing relatively independent effects upon dedicated mechanisms. Clinical experience however, suggests that aphasia rarely presents as isolated impairments, leading many therapists to question the validity of targeting ‘isolated’ boxes and arrows. In response, therapists may instead design therapies for anomia intending to achieve an interactive effect upon the whole language system: improving language deficits in addition to the targeted naming impairment. By providing combinational therapies (i.e. targeting more than one of the domains of semantics, phonology and orthography), therapists aim to strengthen both impaired and preserved mappings and representations involved in a range of language tasks, including naming.

Combinational therapies, which simultaneously target both semantics and phonology, are then perhaps to be expected in the literature, if naming difficulties originate from damage to both semantics and phonology (Lambon Ralph, Moriarty, & Sage, 2002). All of the 453 instances of therapy presented in the 58 anomia studies were analysed to gain an overview of treatment type. Fifty percent of treatments were a combination of semantic and phonological tasks while 42% of the treatments were solely phonological and 8% were uniquely semantic (see Fig 2.3).
Conroy, Sage and Lambon Ralph (2009) provide an example of a study applying 2 different combinational therapies. The study examined the effectiveness of an errorless learning (EL) therapy compared to a more errorful learning (EF) therapy for verb naming. EL is a highly structured technique with a constrained protocol for each item, promoting the likelihood of a correct response. In the EL treatment condition, each participant was provided with an object or action picture, along with its spoken and written name prior to the elicitation of a response. Participants then repeated the name twice, listened again, and produced three final repetitions. The EF treatment condition implemented a more traditional 5-step cueing hierarchy. Cue 1: target picture and broad spoken semantic cue were presented, four repetitions if correct; Cue 2: descriptions of the target were provided, naming was requested with three further repetitions if correct; Cue 3: the initial phoneme and grapheme were presented with two more repetitions if named correctly; Cue 4: the onset and vowel in written and spoken form were provided, with a single repetition request if correctly named; Cue 5: the full target was provided with a single repetition from the participant. Nine participants (4 with a non-fluent aphasia, 2 with fluent anomia, 1 with fluent jargon and another with...
agrammatism) received both therapies. All participants made statistically significant improvements in their naming for both types of intervention.

Combinational therapies assume principles inherent to PDP models, such as interactivity and distributed representations. With such a predominance of combinational therapy in the literature and therapists implementing principles implicitly shared with PDP models in therapy design, some evidence of anomia therapies underpinned by PDP models might be expected. Only 22 of the 58 word-finding therapy studies explicitly referenced a cognitive neuropsychological model (Table 2.1). Of those referenced, connectionist models were the most prevalent but only 3 were PDP in nature.

**Table 2.1 Cognitive neuropsychological models referenced in the anomia studies**

<table>
<thead>
<tr>
<th>Type of Model</th>
<th>No.</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Connectionist</strong></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>9</td>
<td>Abel, Wilmes &amp; Huber, 2007; Best, Herbert, Osborne &amp; Howard, 2002; Biedermann &amp; Nickels, 2008; Martin, Fink, &amp; Laine, 2004; Martin, Fink, Renvall &amp; Laine, 2006; Renvall, Laine &amp; Martin, 2007; Renvall, Laine, Laakso &amp; Martin, 2003; Rieu, Lome &amp; Della Barba, 2001; Wambaugh et al., 2001.</td>
</tr>
<tr>
<td>Distributed</td>
<td>3</td>
<td>Kendal et al., 2008; Kiran &amp; Thompson, 2003; Stanczak, Waters &amp; Caplan, 2006</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>Dotson et al., 2008; Beeson &amp; Egnor, 2006</td>
</tr>
<tr>
<td><strong>Modular</strong></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Box and arrow</td>
<td>6</td>
<td>Basso et al., 2001; Kiran et al., 2001; Spencer et al., 2000; Lorenz &amp; Nickels, 2007; Hickin et al., 2002; Franklin, Beurk &amp; Howard, 2002</td>
</tr>
<tr>
<td>2 stage lexical access</td>
<td>2</td>
<td>Boyle, 2004; Corsten et al., 2007</td>
</tr>
</tbody>
</table>

One such treatment programme with PDP principles at its heart was evaluated in a study by Kendal, Rosenbek, Heilman, Conway, Klenberg & Gonzalez Rothi (2008). Here the authors investigated the effects of a phonological treatment using the topography of the Wernicke–Lichtheim information processing model (Lichtheim, 1885) to construct a PDP model version (See Fig. 2.4).
The treatment program sought to instantiate multi-modal representations of phonemes through activities that built shared connections between acoustic, articulatory, orthographic and concept representations. 10 participants (on average 57.9 months post-stroke) were trained to form concepts of individual phonemes by pairing visual depictions of the articulation; proprioceptive and visual feedback from their own phoneme production and verbal descriptions of the distinctive oral-motor features of each phoneme. The programme trained all consonants and vowels in isolation and in combination (including non-word combinations) and was administered in 2 hourly sessions, 4 times a week, for 12 weeks (96 hours in total). The results suggested that treatment did have a positive effect upon the primary measure (confrontation naming) immediately post-therapy for 8/10 participants and for the secondary outcome measures of phonological production (10/10) and non-word repetition (6/7). In addition, there was generalisation to discourse production for 8/10 participants. The approach assumed that training phonemes and phonological sequence knowledge, would lead to broader generalisation, as knowledge of all phonemes and phonological sequences could support production of all words. At 3 month follow up, 6/8
participant maintained the improvements in naming with 4/7 displaying maintenance effects for phonological production and 5/6 for non-word repetition. The authors concluded that the results were tentative evidence to support the hypothesis that it is possible to improve naming by increasing the opportunity for naming via the phonological route via a phonological treatment.

PDP models can offer more though than principled theory for therapy design. If PDP principles are used to underpin computational model simulations, then the results of the tested hypotheses can directly inform a rehabilitation programme. Yet, such interaction between the two disciplines is rare. Only 2 (Abel, Wilmes & Huber, 2007 and Kiran & Thompson, 2003) of the 14 studies referencing a connectionist framework designed therapy by directly incorporating the predictions of a connectionist computational model. Of these, only Kiran and Thompson’s study (2003) applied the findings from a PDP computational model paper (Plaut, 1996). The authors devised a semantically based naming treatment emphasising the semantic features of typical versus atypical items following Plaut’s (1996) conclusion that atypical items produced greater generalisation when his PDP network was retrained. Four participants with fluent aphasia, who were at least 9 months post onset, were included in the study, which was a case series design. Typicality of categories, their examples and features were developed using controls prior to treatment. Two treatment categories were then included (birds and vegetables) with 16 treated items in each (8 typical and 8 atypical). Each treatment session involved a participant performing the following four tasks for each example of the subset: 1) naming the picture; 2) sorting the pictures by category; 3) identifying semantic attributes applicable to the target example from a set of category features and 4) answering yes/ no questions relating to the semantic features of the target item. Participant 1 demonstrated generalised naming of untrained typical items during
atypical exemplar training. A similar effect was noted for Participants 2 and 4 with improved naming on trained items and generalisation to untrained items (e.g. Participant 2 - treatment on atypical vegetables items resulted in acquisition of trained atypical items and untrained typical vegetable items). Finally, Participant 3 improved on naming of typically trained exemplars but did not show generalisation from typical items to atypical items.

These few studies demonstrate the various ways in which PDP models of rehabilitation can be, and have been, implemented to inform therapy. Whilst the studies indicate the influence of PDP computational modelling towards rehabilitation, they demonstrate the reality that the approach supports only a fraction of therapy design within the anomia literature. The interface between PDP computational modelling guiding anomia treatment is undoubtedly weak (Abel et al., 2007), despite an inclination towards the principles of PDP for therapy design with the predominant combinational therapies. It may prove useful to endeavor to understand the hesitancy in clinically applying PDP computational modelling for future use. In addition, it is of interest to note the limited reference to any cognitive neuropsychological model in the reviewed papers, which may reflect the gradual dissatisfaction with traditional box and arrow models as a framework for therapy design.

2.4 **Anomia: The relationship between Therapy and Assessment**

Developing effective treatments for the remediation of deficits has traditionally involved identifying firstly *which* mechanisms are involved in the particular language process subsequent to examining *how* to target the impaired process/es. Since the problem in anomia arises from damage to semantics, phonology and / or the interaction between these two domains (Lambon Ralph et al., 2000), diagnosis ought to include assessment of naming, semantics and phonology, highlighting both impaired and intact processes. Somewhat less
evident is the question of which therapy will most effective for improving the impaired word-finding process/es – there is little resolution within the treatment literature as to which therapy option is most beneficial. The relationship between assessment and therapy selection has been central to clinical impairment-based therapy, particularly since the introduction of box and arrow information processing models (e.g. Ellis & Young, 1988; Kay et al., 1992). The linear relationship allowed clinicians to identify impaired boxes then to devise and provide a corresponding therapy to remediate the deficit. The rise of more interactive and distributed processing models, has not lessened the need for assessment but it has questioned the direction of the correspondence e.g. innovatively treating shared sets of representations which support both intact and impaired tasks. Determining what the anomia literature says about the general relationship between therapy selection and assessment of anomia may provide further insight into the contribution of PDP models within anomia rehabilitation.

2.4.1 Evidence of assessment and impairment

Identification of impairment was only possible if a participant was assessed, the score was reported and normative data were provided. The first analysis has taken data from 262 of the 283 participants (some individuals participated in more than one study and were only counted once).

A naming assessment was administered in all 283 cases but the particular assessment was only identified for 249 (88%). The Boston Naming Test (Kaplan, Goodglass & Weintraub, 1983) was the most frequently performed (152, 61.0%).

Table 2.2 Naming assessment data from the anomia studies

<table>
<thead>
<tr>
<th>Evidence of a Naming Assessment (N=283)</th>
<th>Type and Number of Naming Test (N=283)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Aachen Aphasia Test naming subtest</td>
</tr>
<tr>
<td>No</td>
<td>Boston Naming Test</td>
</tr>
</tbody>
</table>
Object and Naming Battery | 4
---|---
Western Aphasia Battery | 5
PALPA 54 (frequency) | 7
Test of Adult /Adolescent Word Finding | 8
Philadelphia Naming Test | 5
Other* | 31
Not reported | 34
* Test of Adolescent / Adult Word Finding (German, 1990), Zingeser & Berndt, 1990

By contrast, a test of semantics was only administered to 168 (59.4%) of participants. Five (3%) of those administered with a semantic assessment did not have the specific semantic test documented (Table 4). The most common assessment was one of semantic association: 124 (73.8%) received the picture version of Pyramids and Palm Trees (Howard & Patterson, 1992). It was possible to identify the presence or absence of impairment for 135 (80%) of the 168 assessed: from the 135 with possible semantic impairment, 105 (77.8%) were found to have a semantic deficit.

Table 2.3 Semantic assessment data from the anomia studies
Phonology was assessed in 240 (84.8%) of the participants. In 30 (12.5%) of these cases, the type of assessment used was not reported (Table 2.4). Word repetition was the primary technique for 191 (79.6%): the repetition subtest of Western Aphasia Battery (Kertesz, 1982) was administered to 82 (42.9%) and PALPA 9: imageability x frequency (Kay et al., 1992) was used with 58 (30.4%). Word reading using PALPA 31: imageability x frequency (Kay, et al., 1992) assessed the remaining 19 (7.9%). Identifying the presence or absence of phonological impairment was possible for only 92 (38.3%) of the 240 assessed: 71 (77.2%) of these were found to have a phonological difficulty.

Table 2.4 Phonological assessment data from the anomia studies

<table>
<thead>
<tr>
<th>Evidence of a Phonological Test (N=283)</th>
<th>Type of phonological Test and Number (N=240)</th>
<th>Diagnosis of Phonological Impairment (N=92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes 240</td>
<td>Word repetition</td>
<td>Impaired 105</td>
</tr>
<tr>
<td>No 43</td>
<td>PALPA 9</td>
<td>Unimpaired 30</td>
</tr>
</tbody>
</table>

* Porch Index of Communicative Ability (Porch, 1981); Wortproduktionsprüfung – German test (Blanken, Döppler, & Schlenck, 1999); Lemo (De Blesser, Cholewa, Stadie, & Tabatabaie, 2004); Boston Diagnostic Aphasia Examination (Finnish) (Laine, Neimi, Koivuselka-Sallinen, & Tuomainen, 1997b)
Given that anomia arises as a result of damage to combinations of semantics, phonology and/or the links between, it may be surprising to find that semantics was assessed in only 168 (59.4%) of the total 283 participants. More promisingly, phonology was tested in 240 (84.8%). Yet, determining diagnosis of a phonological impairment was only possible for 92 (38.3%) compared to 135 (80%) diagnosable with a semantic difficulty. These findings indicate a potential for under-assessment and/or the under-reporting of the phonology and semantics skills underlying naming.

2.4.2 Correspondence between therapy and assessment

Establishing a correspondence between therapy selection and assessment of anomia was only possible for those participants with a complete assessment data i.e. where raw scores and normative data were provided to identify impairment (130 participants). The presence or absence of either a semantic, phonological or mixed impairment was subsequently cross-matched with the provision of either a semantic, phonological or combined treatment.

Table 2.5 Instances of therapy corresponding to impairment (for those with complete assessment data)
The findings suggested a combined therapy was most commonly provided (65). A combined approach was most likely to treat a semantic deficit (26), closely followed by the remediation of a mixed impairment (23). A mixed deficit however was also equally as likely to be treated with a phonological therapy (23).

The instances of phonological therapy (55) closely followed the number of combined therapies provided. A phonological therapy was most likely provided to treat a semantic (29) or a mixed impairment (23), whereas a phonological impairment was most likely to be remediated through a combined treatment (16). A phonological impairment was only treated with a phonological therapy in 3 instances.

Semantic therapies were the most infrequent type of therapy provided (10). A semantic therapy was more likely to be applied to treat a phonological deficit (6) compared to the treatment of a corresponding semantic impairment (4).

Combinational therapies were most likely to be the treatment type provided. The finding of combinational therapies simultaneously targeting both semantics and phonology is expected, if word-finding difficulties may originate from damage to both semantics and phonology (Lambon Ralph et al., 2002). Data indicated that whilst phonology was assessed in 84.8% (240), semantics however was only assessed in 59.4% (168) of participants. Underassessment of either of these domains within the literature may impact upon the extent of evident deficits.
(e.g. related impairments supported by the representations in the domains) and/or which therapy might be most appropriate to remediate these impairments. Underreporting of assessment data creates bias by potentially under stressing the degree of severity in semantics and phonology. The underreporting and/or under assessment of semantics and phonology within the anomia literature therefore impacts upon the extent of potential correspondence between therapy and assessment. Combinational therapies were most likely to be provided to remediate semantic and/or mixed impairments. This finding may indicate clinical thinking influenced by PDP type models, which suggest treating shared sets of representations may improved a range of impaired tasks, not necessarily treated directly. There was little evidence of linear relationship were a specific deficit was treated with a corresponding therapy i.e. a phonological deficit treated with a phonological therapy, which may be expected if box and arrow models were used as a framework to underpin rehabilitation.

2.5 The contemporary role of PDP computational modelling in aphasia therapy

Little evidence of a linear relationship between assessment and therapy, alongside a predominance of combinational anomia therapies, may be indicative of a growing dissatisfaction with box and arrow models and, perhaps, an inclination towards alternative frameworks such as PDP type models and computational modelling. Yet, the discovery that only 1 study by Kiran & Thompson (2007) of the 58 reviewed explicitly applied the predictions of a PDP model to guide rehabilitation is suggestive of reluctance to apply PDP modelling within aphasiology. But it is not surprising that the relationship between PDP computational modelling and aphasiology is in its infancy. The limited contribution and application within aphasia therapy may be a simple reflection of the complex nature of PDP modelling and, consequently, the breadth of PDP modelling research to date. Developing networks capable of capturing human performance is highly complex, time consuming and
requires a range of specialist skills. The research method also hinders progress within aphasiology, as sequential progress through performance is required. It is not possible to focus on simulating language recovery without typical performance first capturing typical and impaired performance. The CN literature is therefore reflective of these restrictions with computational CN receiving limited research attention, and only a small proportion focusing upon language processing theory.

Yet, despite these constraints, the body of computational CN work relevant to aphasiology is growing. Firstly, the complexity of the networks trying to reflect the capabilities of human performance is in focus. Single task PDP models have been highly influential in furthering the development of the approach (e.g. reading aloud, Plaut, 1996). However, the networks are not capable of performing a range of semantic, phonological and orthographic tasks within the same network, as the necessary routes have not been simulated. Gradually, more complex models have evolved capable of performing more than one task; for example, multiple reading tasks (Harm & Seidenberg, 2004) and semantic tasks (Rogers et al., 2004). These multiple task models are capable of capturing a more realistic human performance and offer greater potential for insight into the nature of recovery. Multiple task models are frequently trained to produce a number of multimodal tasks from a single modality input. Three models investigating semantics (Dilkina, et al. 2008; Plaut, 2002; Rogers et al., 2004) are exemplified where the networks are capable of completing a range of complex tasks after being trained to produce multiple modality outputs from a single modality input. The multiple task model studies are outlined below.

Plaut (2002) investigated the organisation of semantic representations in a computational simulation of optic aphasia. The architecture of the network had two input groups (Vision and Touch) and two output groups (Action and Phonology) (Fig 2.3). The network was trained to perform an action task and an object task. For the action task, the input to the network was
either the Visual or Touch representation. The network was trained to generate both the name
of the action (phonological representation) and the corresponding gesture (action
representation). For the object task, the network was again presented with either the Vision or
Touch representation and trained to generate the name (using Phonology). The motivation for
activating both Action and Phonology in the action task is that the network will activate all
the knowledge it holds about the action of the presented object. To be successful, the
architecture of a PDP model has to be highly specified. This includes determining the nature
of the patterns of activation to which a network is exposed (inputs) and expected patterns of
activation (outputs) in training. The training regime of these PDP models (which are capable
of completing multiple tasks) is one of multiple modality outputs from a single modality
input.

Similarly, Dilkina et al. (2008) explored semantic processing by examining the relationship
between reading and naming performance. A single system for both semantic and lexical
processing was proposed, where the network had to perform both semantic and lexical tasks.
The architecture of the network consisted of orthographic, phonological, visual and action
input / output layers (Fig. 2.5). The network was given either a visual or an orthographic
pattern as input for each presentation. From this input the network was trained to produce
either one or four patterns output – thinking, reading, reading aloud and spoken naming.
Rogers et al. (2004) devised a network capable of performing a variety of semantics tasks. The network architecture consisted of a semantic layer, a verbal layer (names and description - perceptual, functional and encyclopaedic) and a visual layer (Fig 2.6).

The connections between the domains were bidirectional, therefore the visible features were able to act as both inputs and outputs. In training, the network was presented with a single name, a verbal pattern or a visual pattern and gradually relevant associations were learnt between names, descriptions and appearances. After training, the performance of a damaged network was compared to that of people with semantic dementia across a range of tasks: naming, word sorting, picture sorting, word-to-picture matching, drawing and delayed copying. The model captured similarities amongst objects in both the visual and verbal domains, which may lead to a structure that is not evident in an individual modality.

The development of multiple task models is of growing value. As the networks attempt to more closely replicate the reality of human performance, so to will they more closely
simulate resultant damage and recovery. But such contribution is not imminent. The increasing number of networks not only simulating single language task performance and aphasic behaviour but also the recovery and rehabilitation of impaired language performance are therefore critical. The computational simulation of recovery in the literature is however sparse and has been primarily been restricted to word reading (Welbourne & Lambon Ralph, 2005).

Plaut (1996) focused on factors affecting the degree and speed at which reading behaviour is re-established in an attempt to demonstrate correspondence between relearning in models and patients. Three simulations explored the effect of damage location upon generalisation; the effect of item selection upon generalisation and changes in error pattern during relearning. The network showed greatest generalisation when damaged at the level of semantics and differed depending upon the typicality of retrained items. Retraining with atypical items produced greater generalisation despite typical items being more easily relearned. Training typical items improved performance only on trained items with a deterioration in the performance on atypical words. The proposed mechanism behind the generalisation was the greater variation of semantic features in atypical items resetting a larger number of feature parameters in the damaged region. Whilst Plaut accepted the limitations of the study, he emphasised the potential of the approach and stated that the ultimate test of adequacy would be the extent to which generated hypotheses result in improved patient therapy.

More recently, Welbourne and Lambon Ralph (2005) investigated the effect of rehabilitation in conjunction with spontaneous recovery. The authors highlight the importance of distinction between networks simulating recovery and rehabilitation. The study addressed a number of therapeutic issues similar to those of Plaut (1996) including stimuli and generalisation. Additional training to the network on items a human is already best at i.e. regular words, led to greatest performance. If the training set consisted of high frequency
regular words, the network achieved an overall accuracy of near 60% (the network moved from 4% to 57% accuracy on the remaining untrained words). There were two explanations as to why this finding occurred. Regular word reading uses a common set of consistent spelling-to-sound correspondences, therefore learning on one word may support learning for another word. Furthermore, a small improvement for regular words can outweigh a larger improvement on irregular words since regular items are more frequent. In addition, the effectiveness of rehabilitation was greater when provided earlier rather than later following damage (irrespective of stimuli choice) attributed to greater plasticity immediately following damage. Retraining a small set of words did result in generalisation to a much larger set of untrained words. As the factors that influence the clinical difficulty of showing generalisation can be controlled in a PDP simulation, it highlights just one possible benefit of this approach to clinical practice.

Given the relatively recent emergence of complex PDP models that are yet to examine recovery of several tasks and the limited amount of single task PDP computational studies addressing relearning, the contribution of PDP modelling to aphasiology requires creative application to the clinical rehabilitation of impairments, such as anomia. Comparing the training regimes of the relevant PDP models with the reviewed anomia therapies is perhaps a first step. Data were drawn from 453 instances of therapy provided to all participants across the 58 anomia studies (including studies which investigated one or more different therapies in a single participant). The input/s and output/s for each therapy task received by each participant were categorised. Input categories included picture, spoken, written, gesture and other. Outputs categories included speech, writing, gesture, semantic categorisation, phonological categorisation and other. An input/output was considered multimodal if more than one category was provided during an instance of therapy.
The results show the training provided in the anomia therapies contrasts with the regimes of the exemplified computational models. Multimodal input with single modality output was predominant (Fig 2.7). In terms of inputs, there were only 21 instances of single input, which consisted solely of picture presentation, and in every case a corresponding single output (spoken) was sought. For the remaining 432 applications of therapy, multiple inputs were provided. Of these, 190 presentations involved visual (picture), spoken and written modality combinations and 145 instances involved visual (picture) and spoken modality. Three hundred and thirty three of these multiple input events expected only a single modality output, of which 297 were spoken. There were 99 instances of multiple modality outputs; the majority (48) were spoken and semantic categorisation (see Table 2.6).

Table 2.6 Type and number of therapy inputs and outputs across the anomia studies

<table>
<thead>
<tr>
<th>Type of Inputs</th>
<th>No.</th>
<th>Type of Outputs</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Modality</td>
<td></td>
<td>Single Modality</td>
<td></td>
</tr>
<tr>
<td>Spoken</td>
<td>0</td>
<td>Spoken</td>
<td>318</td>
</tr>
<tr>
<td>Written</td>
<td>0</td>
<td>Written</td>
<td>14</td>
</tr>
<tr>
<td>Picture</td>
<td>21</td>
<td>Semantic Categorisation</td>
<td>22</td>
</tr>
</tbody>
</table>
Many people with aphasia have some degree of word-finding difficulty, which is a frustrating and distressing aspect of their aphasia (Nickels, 2002). It is therefore perhaps not surprising that single modality spoken output responses are most frequently elicited in remediating the impairment. However, as clinical experience suggests that aphasia is a multimodal language impairment that rarely presents in isolated deficits (such as pure anomia). It is somewhat unexpected to then find anomia research therapies in recent years do not reflect this observation and have not furthered techniques promoted in the earlier literature. For example in the mid 1980’s, in a seminal anomia paper, Howard, Patterson, Franklin, Orchard-Lisle and Morton (1985) advocated multimodal techniques to improve word retrieval: eliciting a word using repetition, phonemic cueing, reading, writing or listening. Strengthening the representations within semantics and phonology used for naming, may create a widespread interactive effect upon the language system, improving all impaired tasks that are underpinned by the same shared set of representations. The clinical value of a multimodal anomia treatment may then be the improvement of non-targeted language tasks in addition to improvement in the desired targeted task i.e. anomia.

### 2.6 Conclusion
The intention of this review was to examine the current role of cognitive neuropsychology within aphasiology. To achieve this, the review focused on the potential contribution of PDP computational modelling to therapy design by examining if and how PDP computational models were used, as a reference for therapy, and to what extent therapy was multimodal. In addition, a further insight into CN models guiding treatment was investigated by considering the general relationship between therapy selection and assessment of anomia.

Reviewing the current anomia literature revealed a limited amount of studies explicitly referencing cognitive neuropsychological models in guiding therapy design. Of those referenced, PDP models were the most prevalent. The findings from PDP models of rehabilitation however supported a fraction of clinical decision-making regarding therapy - only 2 studies explicitly applied predictions of a model. Such a limited number of studies utilising PDP models of rehabilitation may indicate reluctance within aphasiology to embrace PDP computational modelling as a guide to therapy design. Yet, the predominance of combinational therapies (i.e. targeting more than one of the domains of semantics, phonology and orthography) may indicate an inclination toward principles inherent to PDP models. These principles are more able to account for the clinical presentations of patients – a range of impairments across language tasks. By providing combinational therapies, therapists may be attempting to simultaneously strengthen impaired mappings and representations involved in a range of language tasks whilst also utilising those that are preserved. The argument towards PDP principles guiding treatment may be further strengthened with the finding that there is little evidence of a linear relationship between therapy selection and assessment – which might have been expected if box and arrow models underpinned treatment.

Despite an emerging tendency towards PDP principles within aphasiology, the limited number of therapy studies explicitly applying the predictions of a PDP models influencing rehabilitation indicates reluctance to apply the approach. Application of the approach may be
influenced by a multitude of factors i.e. limited PDP research investigating recovery and the ability of the networks to accurately capture human performance. Clinical experience suggests aphasia is a multimodal language impairment that rarely presents in isolated deficits (such as pure anomia). Development of more complex PDP models, which are capable of performing more than one language task, may offer greater potential for insight into the nature of recovery - rehabilitation of a range of impairments may be possible within one model. Complex models have emerged within recent years but are yet to examine recovery of several tasks. Comparing the training regimes of single language task models with the reviewed anomia therapies is perhaps a first step. The results showed that the training provided in the anomia therapies contrasted with the regimes of the identified computational models. Multimodal input with single modality output was predominant – an unsurprising finding perhaps given that speech is frequently the impairment a person with aphasia wishes to address in therapy. However, given the multimodal nature of aphasia, it is somewhat unexpected to have found the anomia research therapies in recent years do not provide a greater degree of both multimodal input and output therapies. The clinical value of a multimodal anomia treatment may be the improvement of non-targeted language tasks in addition to improvement in the desired targeted task i.e. anomia. A therapy strengthening the representations within semantics and phonology used for naming, may create a widespread interactive effect upon the language system - improving all impaired tasks that are underpinned by the same shared set of representations. A research study is therefore warranted to examine whether such a multimodal therapy may be more effective in the rehabilitation of anomia, and, other impaired language tasks.
Chapter 3

Methodology

3.1 Study Aims and Hypotheses

The key objective of the study is to determine whether a multimodal therapy may be more effective in the rehabilitation of anomia, and other impaired language tasks, through the elicitation of a word in multiple modalities. Determining the effect of cross-modal input and output upon anomia and other language tasks would be of substantial benefit, given that aphasia is a multimodal language impairment.

The research aims for the current study are:

1. To determine the relative effects of an Item focused (multimodal) therapy compared to a Task focused (unimodal) therapy upon naming accuracy.

2. To determine the effects of Item focused and Task focused therapy upon naming immediately after therapy and at 1-month follow-up.

3. To examine the effects of the Item focused therapy and the Task focused therapy upon other language tasks not directly targeted by the therapy: repetition, spelling to dictation and reading aloud immediately after therapy and at 1 month follow-up.

The resultant hypotheses for the study then are:

1. Immediate gains in the targeted impairment of naming will be greater for the Item focused than the Task focused therapy.

2. Immediate gains in the targeted impairment of naming will be more effectively
maintained for the Item focused than the Task focused therapy – irrespective of the magnitude of the immediate gain.

3. Immediate gains in the non-targeted impairments of repetition, spelling to dictation and reading aloud will be greater for the Item focused than the Task focused therapy.

4. Immediate gains in the non-targeted impairments of repetition, spelling to dictation and reading aloud will be more effectively maintained for the Item focused than the Task focused therapy – irrespective of the magnitude of the immediate gain.

The following sections outline the experimental design of the study, the assessment battery and the nature of the therapies, which intended to enable these aims and hypotheses to be addressed.

3.2. Recruitment and Inclusion

Eight participants were recruited from NHS Speech and Language Therapy Services and the voluntary sector in the North West of England. Appropriate ethical approval was sought and provided for both sectors from MRec and The University of Manchester. Inclusion criteria specified monolingual English speakers with moderate-severe word-finding difficulties (since the therapy aimed to target anomia) and phonological errors in speech following stroke (to ensure a degree of preserved ability across tasks). Time post onset was set at a minimum of 6 months to avoid the factor of spontaneous recovery. History of a progressive neurological condition (e.g. dementia) excluded participation. Global aphasia, significant motor speech difficulties (Apraxia of Speech / dysarthria) and / or significant cognitive difficulties also excluded a participant from the study; as such participants would not be able to participate in
certain therapy tasks (e.g. repetition) and task understanding may be impaired. Vision and audition needed to be corrected to an extent that enabled participation in therapy.

All participants were screened using PALPA 53 (Kay et al., 1992), which includes naming, reading aloud, spelling to dictation and repetition across the same items. Three conditions were required for entry to the study: a naming score below 34/40 (85%), phonological errors in naming and impairment in at least one of the three other language skills (repetition, reading aloud and spelling. Those scoring below 6/40 (15%) on any of the 4 of the language tasks were to be excluded from the study. This ensured a degree of preserved ability across tasks and the viability of engagement in the item focused therapy (which included a range of spoken and written production tasks) and allowed for the examination of improvement across tasks following therapy.

3.3 **Background Assessment**

A comprehensive battery of linguistic and cognitive assessment was carried out with each participant. Linguistic assessment focused on single word processing to enable profiling of each participant’s capabilities in the domains of semantics, phonology and orthography and the interaction between the domains. Cognitive assessment concentrated on memory, attention and executive functioning skills to enable consideration, where relevant, of cognition to therapeutic outcome. The contribution of participants linguistic and cognitive profiles to therapy outcome are discussed in Chapter 5 (Discussion). The assessment battery used a similar battery from Read (2009) with some additional tasks. Full details of the published and unpublished tests used are given below.
3.3.1 Assessment of Aphasia Classification

The shortened Boston Diagnostic Aphasia Examination-3 (Goodglass, et al., 2001) was conducted to enable classification of each participant’s aphasia.

3.3.2 Linguistic Assessment

a) Naming

Noun retrieval was assessed using three picture-naming tests:

1. The Boston Naming Test (Goodglass et al., 2001) – 60 items decreasing in frequency.
   Semantic and phonological cues were provided as the test dictated. The test was discontinued after 8 consecutive no responses.

2. 64 Item Naming Test (Bozeat, Lambon Ralph, Patterson, Garrard & Hodges, 2000)
   included 64 line drawings representing familiar objects in three living items categories (animals, birds and fruits) and three non-living item categories (household items, tools and vehicles).

3. Graded naming test (Warrington, 1980) comprised progressively difficult, low frequency stimuli to identify those with subtle naming difficulties. The test was only carried out with participants scoring above 70% (44) on the 64 Item Naming Test (Bozeat, Lambon Ralph, Patterson, Garrard & Hodges, 2000).

b) Semantics and noun comprehension

The integrity of semantic representations and the interaction of semantics with other domains were assessed through four tests. The first two tests were relatively ‘pure’ semantic tasks, as they did not require phonological output:
1. The three-picture version of Pyramids and Palm Trees Test (Howard & Patterson, 1992) required a participant to match a series of three pictures (item, target and distractor) based on semantic relatedness for 52 items.

2. A written synonym judgement task (Jefferies, Patterson, Jones & Lambon Ralph, 2009). The test again required participants to match written words based on semantic relatedness. Ninety-two written probes were presented with two foils and a target at each trial. All probes, targets and foils were matched for frequency and imageability.

3. Spoken word-to-picture match (Bozeat, et al., 2000) assessed the interaction between phonology and semantics. The test consisted of 64 pictures divided equally across eight semantic categories. At each trial, the participant was asked to select the target picture from an array of ten pictures – 9 within-category pictures and the target.

4. Written word-to-picture match (Bozeat et al., 2000) examined the interaction between orthography and semantics. The items and procedure were as for the spoken word-to-picture match version but in written form.

c) Phonology

Four tasks requiring varying degrees of phonological processing were used to assess the status of the phonological domain:

1. Delayed and immediate word repetition – 48 monosyllabic words matched for frequency were taken from Welbourne and Lambon Ralph (2007);

2. Delayed and immediate non-word repetition – 42 non words were taken from Glushko (1979);
In both repetition tasks, participants were asked to repeat a target, count to five aloud and then attempt a second repetition of the target.

3. Phonological manipulation (addition and subtraction) - required participants to add and subtract the initial phoneme to and from the target. All 48 items were taken from Patterson and Marcel (1992) and were used both for addition and subtraction;

4. Auditory rhyme judgement – the test consisted of 48 (24 rhyming and 24 non-rhyming) items from Patterson & Marcel (1992). The participant was asked to listen to each pairs of words before deciding whether the pair rhymed or not.

d) Orthography

Participants’ letter knowledge was examined using three tasks:

1. Letter writing - using PALPA 22 (Kay et al., 1992) the participant was asked to write the 26 letters presented in a random order in response to the spoken names;

2. Letter Identification - PALPA 23 (Kay et al., 1992) required the participant to select the 26 written letters in response to their spoken names from five distractors;

3. Letter discrimination in word string - PALPA 21 (Kay et al., 1992) required discrimination of similar or different letter combinations within 2 letter strings.

e) Spelling to dictation

The interaction between phonology, semantics and orthography was assessed using:

1. Imageability x frequency - PALPA 40 (Kay et al., 1992) which consisted of 40 items with manipulation of the two variables across the 40 items (10 x HIHF, HILF, LIHF, LILF);
2. Regularity - PALPA 44 (Kay et al., 1992) consisted again of 40 items (20 regular and 20 irregular items).

In both tests, a word was spoken aloud by the tester and the participant attempted to write down the word. All tests were discontinued after 10 consecutive no responses.

f) Reading Aloud

Three reading tests were conducted. Two single-word reading tasks were included to assess the interaction between orthography, semantics and phonology and a third non-word reading task examined mapping between orthography and phonology:

1. Imageability - 48 items (24 HI and 24 LI) were taken from Welbourne and Lambon Ralph (2007);

2. Regularity x frequency – 96 items were taken from Taraban and McClelland (1987) with manipulation of the two variables across the items (24 x HFReg, LFReg, HFIrreg, LFIrreg);

3. Non-word – 42 nonwords were taken from Glushko (1979).

All tests were discontinued after 10 consecutive no responses.

3.3.3 Cognitive Assessment

a) Memory

1. Copy, immediate and delayed recall of the Rey Complex Figure (Meyers & Meyers, 1995). The test required a participant to copy a complex geometric figure and to draw from memory the figure five and thirty minutes after the initial copy.
2. Corsi block tapping task (Kessels, van Zandvoort, Postma, Kappelle & de Haan, 2000). The task is an assessment of visuo-spatial short-term memory. The examiner tapped a series increasing in length, which the participant was required to repeat in sequential order.

3. Digit Span is a test of verbal short-term memory. The participant was required to repeat a series of numbers increasing in length. The number series presented were taken from the Corsi block-tapping task.

b) Executive and Attention skills

1. Ravens Coloured Matrices Test (Raven, 1962) is a test of abstract reasoning and concept formation. The test consists of a series of coloured pattern designs with a segment missing. Participants were asked to select the correct missing pattern from a choice of 6 visually similar segments.

2. 5 point test (Goebel, Fischer, Ferstl, & Mehdorn, 2008) is a pattern generation test assessing initiation, strategy use and self monitoring skills. A participant is presented with a set of boxes containing 5 points. The participant must then generate as many novel designs as possible within 3 minutes by connecting a minimum of 2 dots with a straight line. Scoring of the test covers 4 aspects: productivity, strategy use, flexibility and rule breaking.

3. 2 subtests of The Test of Everyday Attention (TEA) (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994). The elevator counting subtest assesses sustained attention, as it requires participants to count the number of heard tones presented at random intervals in a series. The elevator counting test with distraction examines divided
attention and requires the participant to listen again to a series but to count only low
tones. A written number line was provided in both tasks to aid number identification.

3.4 Experimental design

A within-group crossover design was used to compare 2 types of therapy - a traditional Task
Focused (TF) therapy and a novel Item Focused (IF) therapy. This crossover design has been
successfully implemented in other aphasia therapy studies comparing two methods (e.g.
Abel, Wilmes & Huber, 2007; Greenwood, Grassly, Hickin & Best, 2010; Wambaugh et al.,
2001). Participants were assigned into 2 groups (Group 1 and Group 2) dependent upon their
geographical location. Whilst 8 participants were recruited into the study, only 6 completed
it (1 participant died prior to starting the crossover therapy and another left the study half
way through to go travelling). Group 1 first received the IF therapy, followed by the TF
therapy, and included 3 participants (EB, AD and RW) whilst Group 2 also included 3
participants (AA, GW and BR) who initially received the TF therapy and then the IF
therapy. Participant profiles are presented in the following chapter.

![Diagram of crossover design for participants]

*Fig 3.1. Cross over design for participants*
All participants completed the pre-therapy assessment battery of linguistic and cognitive tests, which took, on average, 8 sessions of 60-90 minutes. Both therapy blocks were provided intensively over 2 weeks. Each participant was seen for 10 sessions within each 2-week block – comprising of 9 therapy sessions and 1 immediate post-therapy assessment session. A session involved on average 60 minutes of direct intervention for both therapies. A rest period of 10 weeks was inserted in between the different therapy blocks to ensure no contamination effect between the therapies. In addition to the immediate post therapy assessment session, a follow-up session was carried out 4 weeks after the final therapy session in each block.

![Fig 3.2 Time line for participant involvement](image)

3.5 Therapy

Item Selection

Items failed on two occasions were selected as potential therapy and control items for each participant. Items from the Object and Action Naming Battery (OANB) (Druks & Masterson, 2000) and International Picture Naming Project (IPNP) [http://crl.ucsd.edu/experiments/ipnp/1stimuli.html](http://crl.ucsd.edu/experiments/ipnp/1stimuli.html) were used to generate items for therapy, as they included a range of items varying in lexical complexity. The OANB contained 262...
items – 162 nouns and 100 verbs – whilst 412 items were included from the IPNP (298 nouns and 114 verbs). A cut off of 5 seconds was implemented for each item and all errors were recorded and transcribed. Sixty nouns and thirty verbs failed twice were required in total for each participant. Accuracy scores for the items were recorded. Participants were subsequently asked to name those items failed at the first attempt. If, at the end of this process, the required number of 90 possible items (plus at least 10 surplus items) had not been gained, the process was repeated with the black and white line drawings from the IPNP until the necessary target number was reached. An additional third stage was added for participant EB. A small subset of low frequency nouns were selected using the same frequency level as the low frequency items failed in the OANB and IPNP. Frequency was determined by using N Watch (Davies, 2005). Pictures for the subset were then selected from the Internet and the same procedure was followed as for the OANB and IPNP pictures.

Three word lists were created for each participant for use in the TF therapy, the IF therapy and as a control set. Each list contained 20 nouns and 10 verbs. The word lists were individual to each participant. For each participant, the 3 word lists were matched for imageability, frequency, regularity, letter length and phoneme length by establishing the mean values for each variable using N Watch (Davies, 2005) and then using T-tests to make sure there was no significant difference.

*Baselines and Post Assessment*

The primary outcome measure was naming accuracy for an item. Secondary outcome measures are repetition, spelling to dictation and reading aloud for the same items, allowing for examination of any indirect improvement in performance across tasks. Use of consistently failed items ensured zero naming baselines for each participant and enables clear comparison
of any effects from the different therapies (Conroy et al., 2009). Once the individualised three word lists had been prepared, each participant was asked to repeat, read aloud and spell to dictation each of the three word lists across three sessions (using a Latin square method). Each session involved a word list presented in a randomised order either for repetition, spelling to dictation and reading aloud. Cut offs of 5 seconds were implemented for the spoken tasks and 10 seconds for spelling to dictation. Accuracy of the first attempt was documented and all errors were recorded and transcribed to enable error analysis.

In the post therapy assessment session, the appropriate therapy word list was tested. Naming was assessed initially using the same picture stimuli as at baseline (OANB and IPNP pictures) – different images were used during therapy. Once naming had been completed, the participant was then asked to repeat the list; spell to dictation the treated words and finally read the word list aloud. The 4-stage procedure was then replicated for the control item list within the same session. Within each task for each word list, the items were presented in a randomised order.

*Therapy protocol*

Picture stimuli for all items were colour photographs selected from the Internet. Five different exemplars of an item were selected, because learning of an item in development is not based upon a single example (Harley, 2001). Each of the 5 sessions in the first week used a different exemplar, and the sequence was repeated up to exemplar 4 (for the final session 9) in the second week. Verbs were presented in the present tense (-ing) form but all forms were accepted in response, as the study was not investigating this aspect of verb use.
All of the targets from the corresponding therapy word list were presented at each session in a random order.

Group 1 received the TF therapy initially followed by the IF therapy after a 10 week gap. Group 2 received the IF therapy first followed by TF therapy again 10 weeks later. All sessions were carried out in the participants’ own homes by the same clinician.

3.5.1. Item Focused (IF) therapy

Item focused therapy involved a series of language tasks completed for each item in turn (see Appendix 3 for an example of the first 3 tasks for a noun item):

1. Spoken word-to-picture match (SWPM)
2. Written word-to-picture match (WWSM)
3. Semantic Features
4. Picture Naming
5. Spelling Rearrangement
6. Reading Aloud
7. Repetition

Multimodal representations are encouraged for each item through input and output tasks across semantics, phonology and orthography. The therapy task sequence aimed to activate semantic representations initially, with subsequent activation of phonological and orthographic representations.
1. Spoken word-to-picture match

After hearing the target item, a participant selected the target picture from a choice of nine semantically related picture distractors. Target and distractor pictures were presented on an A4 page. While the location of the target and distractors was randomised for each presentation, the distractors remained the same for each item. If no response was produced after 10 seconds or an incorrect response was produced, the therapist identified the target.

To generate the required distractors for all participants, all noun and verb target items were grouped into appropriate semantic categories. Nine distractors were produced for each category. For noun items, distractors were primarily coordinates. Associates were additionally used when necessary (depending upon the extent of the coordinates within a category). For example, coordinate distractors for ‘food’ category were ‘burger, quiche, scone, cake, cheese, chicken, bacon, crisps’ and ‘chocolate’ to be used for the target items ‘bread, biscuit, sausage’ and ‘sandwich’. For the target verb ‘measuring’, the category ‘manual actions’ included distractors ‘raking, digging, hammering, sweeping, planting, drilling, sawing, mowing, painting’.

2. Spoken word-to-written match

A participant selected the target picture after hearing the target from a choice of nine orthographically related written word distractors. Target and distractor words were presented on an A4 page with a randomised presentation order for the target and distractors at each presentation. The distractors remained the same for each item. If no response was produced after 10 seconds or an incorrect response was produced, the therapist identified the target.

Written distractors were produced individually for each item. Distractors were primarily orthographic neighbours to the target, supplemented by orthographically similar words. Word
class was not monitored for and so distracters could potentially include nouns, verbs and
adjectives. For example written distractors for ‘bread’, were ‘break, bream, read, dread, tread,
bead, brad, breed’ and ‘broad’. For the verb ‘measuring’, orthographic distractors are
‘meandering, meshing, moistening, meagre, meaner, meowing, reassuring, pressuring’ and
‘leisure’.

3. Semantic Features

The participant answered 10 Yes / No (5 positive / 5 negative) questions based upon the
semantic features of an item. The participant had the target picture in front of them (written
form) and together the therapist and participant read the ten questions (spoken form) e.g.
[bread] – positive superordinate category question ‘is it food?’; negative superordinate
category question ‘is it clothing?’; positive use question ‘do you eat it?’; negative use
question ‘do you drink it?’. The therapist corrected incorrect responses.

For nouns, the task was a modified version of Boyle’s (2004) Semantic Feature Analysis
(SFA) where a participant is asked to generate, for each item, the superordinate category, its
use, an action linked to it, its location and a physical property. Verb questions were adapted,
using the same modification as Wambaugh and Ferguson (2007). The 5 feature categories for
verbs are the person, tool/s required, motion, location and reason for the action. The modified
therapy task implemented did not use feature generation due to time constraints within a
session.

For each of the 5 feature categories up to 5 examples were generated, depending upon the
item. For example, for [toothbrush], the superordinate category consisted of ‘personal item’;
category use was ‘for cleaning teeth’; physical properties category consisted of ‘has bristles,
made of plastic, has a handle, has a head, is light’ and location category included ‘in the
bathroom’. Five different sets of questions were produced to incorporate as many different
examples of a feature as possible. These 5 sets of questions were presented in sequence for
sessions 1-5 and the first 4 sets were repeated again for sessions 6-9. The sequence of
questioning was always the same, but the order of positive / negative responses varied as did
the distractors for the negative questions.

4. Naming

The participant read and named the target picture. If there was no response after 5 seconds or
an incorrect response was produced, the therapist modelled the target and asked for
repetition. The first attempt was recorded and transcribed.

5. Spelling Rearrangement

Letter tiles for the target word were randomly presented and the participant rearranged the
tiles to spell the item. No distractors were provided. Incorrect arrangements were recorded
and corrected by the therapist.

6. Reading Aloud

The participant read aloud the rearranged word. Production was transcribed for the first
attempt and the therapist modelled correct production for an additional repetition.

7. Repetition

The participant was asked to repeat the therapist’s model of the target. The first production
was documented and transcribed. If incorrect, the therapist repeated the model for a further
repetition attempt.

3.5.2. Task Focused (TF) therapy
TF therapy was a naming task using a increasing semantic, phonological and orthographic cue hierarchy (See Fig 3.3 and 3.4). Whenever the participant made an error in production a step-up hierarchy was implemented. The participant proceeded incrementally through the cue hierarchy until the picture was named correctly. The following time the participant was shown the same picture (both within and between session) they started again at Cue Level 1. Where no error was made, the participant proceeded immediately to the next item picture.

Cue 1:
The initial cue consisted of presentation of the object or action picture and a request for the participant to name the item. For verbs, the present tense –ing form was provided but all responses were accepted. If the response was correct the next item was presented. If incorrect, the second cue was given.

Cue 2:
The second cue provided the superordinate category for the item alongside the picture e.g. [kettle] ‘it is a household item’. Following this, the participant was asked to name the target. For verb items, the general action group was offered e.g. [sweeping] ‘it is a cleaning activity’. If the response was correct the next item was presented. If incorrect, the third cue was given.

Cue 3:
The third cueing stage offered a semantically related item or action in addition to the picture e.g. [kettle] ‘it is similar to a saucepan’. Correct response led to presentation of the next item whilst incorrect led to the next cue level.

Cue 4:
In addition to the picture, the fourth cue involved an initial phonemic and graphemic prompt e.g. [kettle] /k/ K. If the item was CCVC, the consonant cluster was provided. If the item was multisyllabic, the first syllable was provided. Incorrect production resulted in the 5th cueing stage whereas correct production resulted in presentation of the next item.

Cue 5:

The fifth cue offered the onset and vowel presented in both spoken and written form alongside the picture. In bi- or multisyllabic words, CVC or CCVC cues were given e.g. [kettle] ‘ket’ KET. Participants were typically successful at this cue level but if not the final cue was provided.

Cue 6:

The final cue involved the picture with whole word in spoken and written form for single repetition.

<table>
<thead>
<tr>
<th>Level:</th>
<th>Cue type</th>
<th>Cue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naming</td>
<td>‘This is a…?’</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Superordinate category</td>
<td>‘It is a household item. It is a…?’</td>
</tr>
<tr>
<td>2</td>
<td>Semantic similarity</td>
<td>‘It is similar to a saucepan. It is a…?’</td>
</tr>
<tr>
<td>3</td>
<td>First sound &amp; grapheme</td>
<td>/k/ (K)</td>
</tr>
<tr>
<td>4</td>
<td>First syllable &amp; associated graphemes</td>
<td>/ket/ (KET)</td>
</tr>
<tr>
<td>5</td>
<td>Repetition</td>
<td>‘/ketl/’ (KETTLE)</td>
</tr>
</tbody>
</table>

*Fig 3.3 Example of noun cue card*

<table>
<thead>
<tr>
<th>Level:</th>
<th>Cue type</th>
<th>Cue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naming</td>
<td>‘This person is…?’</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Superordinate category</td>
<td>‘It is a cleaning activity. This person is…?’</td>
</tr>
</tbody>
</table>
Matching the Item focused and Task focused therapies

Ensuring that the two therapies were as equal as possible in terms of exposure to items and item information proved problematic due to their distinctive natures. The therapies were primarily matched on therapy exposure time – every therapy session lasted for 1 hour. The TF therapy was quick to administer compared to the IF therapy. The items were therefore cycled through a number of times to ensure the 1-hour therapy exposure time. The number of cycles differed for each participant but 4 cycles was average. Because of the number of tasks per item for the IF therapy, items were only cycled through once. It was not therefore possible to definitively match the number of production attempts across the two therapies. For the IF therapy, there were 6 possible production attempts per item in naming, reading aloud and repetition (2 possible attempts per task incorrectly produced), whilst the TF therapy also had six possible production attempts per item (an initial naming response followed by five further attempts only if incorrect responses continued to be provided at each cue level). The repeated exposure of items in this treatment increased the total number of production attempts.
Chapter 4

Participants

4.1 Participant Information

Biographical information and general characteristics are described below for the 6 participants who completed the study. Participants varied in their time post onset, aphasia difficulties and severity. More detailed linguistic and cognitive assessment data are provided later in the chapter.

1. BR

BR was a 67-year-old right-handed male. He left school at 15 years of age and was a retired professional photographer. He suffered a left hemisphere infarct involving the lentiform and caudate nucleus 6 months prior to the start of the study. He had a unilateral left sided high frequency hearing loss that was corrected with a hearing aid. His speech was non-fluent with phonological errors.

2. RW

RW was a left handed, 65 year old female. She was a retired secretary and had received a basic secondary school education. She suffered a stroke over twelve months prior to the study and had a residual left sided hemiplegia. Her speech was non-fluent, consisting primarily of stereotyped and repetitive utterances, which she supported occasionally with single word writing.

3. GH

GH was a 75-year-old male, right-handed and a retired joiner. He left school at 15 years of age to begin an apprenticeship. He suffered a left hemisphere stroke one year
before the study with a subsequent right-sided hemiplegia. His speech was non-fluent with phonological and semantic errors.

4. **AA**

AA was a 67-year-old right-handed female. She had received a university education and previously worked as a tax inspector. She suffered a left hemisphere stroke 2 years prior to the study, which resulted in a dense right hemiplegia requiring wheelchair use. Her speech was markedly non-fluent which she supported with single word writing and occasional gesture.

5. **AD**

AD was a 73-year-old right-handed female. She received a basic education, leaving school aged 14 years and retired after a career in accounts computing. Sixteen months before the study, she suffered a left hemisphere stroke and had a right-sided hemiplegia leaving her unable to walk independently. Her speech was fluent with frequent ‘conduit d’approche’, phonological and mild apraxic errors.

6. **EB**

EB was a 49-year-old right-handed female. She received a basic secondary school education and was working as a social services care manager at the time of her stroke. Nine months prior to inclusion in the study she suffered a large left cerebral hemisphere infarct. Her speech was fluent with moderate phonological and mild apraxic errors.
Table 4.1 General characteristics for participants (Age, gender, handedness, number of years education, lesion information, months since CVA, Language screen scores)

<table>
<thead>
<tr>
<th>Participant</th>
<th>BR</th>
<th>RW</th>
<th>GH</th>
<th>AA</th>
<th>AD</th>
<th>EB</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (on entering study)</td>
<td>69</td>
<td>64</td>
<td>75</td>
<td>67</td>
<td>73</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Female</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Handedness</td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
<td></td>
</tr>
<tr>
<td>Number of years education</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>16</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td>Retired photographer</td>
<td>Retired secretary</td>
<td>Retired carpenter</td>
<td>Retired high grade tax inspector</td>
<td>Retired account manager</td>
<td>Retired Social services care manager</td>
<td></td>
</tr>
<tr>
<td>Lesion information</td>
<td>Left infarct involving lentiform &amp; caudate nucleus</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>Left cerebral infarct</td>
<td></td>
</tr>
<tr>
<td>Months since CVA (On entering study)</td>
<td>6</td>
<td>12+</td>
<td>11</td>
<td>24</td>
<td>16</td>
<td>7</td>
<td>39.8 (0.35)</td>
</tr>
<tr>
<td>PALPA 53 naming</td>
<td>6</td>
<td>8</td>
<td>20</td>
<td>15</td>
<td>19</td>
<td>24</td>
<td>39.79 (0.83)</td>
</tr>
<tr>
<td>PALPA 53 repetition</td>
<td>31</td>
<td>36</td>
<td>33</td>
<td>39</td>
<td>26</td>
<td>32</td>
<td>39.5</td>
</tr>
<tr>
<td>PALPA 53 spelling to dict.</td>
<td>16</td>
<td>1</td>
<td>0</td>
<td>34</td>
<td>20</td>
<td>33</td>
<td>39.5</td>
</tr>
<tr>
<td>PALPA 53 reading aloud</td>
<td>34</td>
<td>8</td>
<td>20</td>
<td>34</td>
<td>26</td>
<td>33</td>
<td>39.96 (0.19)</td>
</tr>
<tr>
<td>BNT</td>
<td>1*</td>
<td>4*</td>
<td>10*</td>
<td>12</td>
<td>13</td>
<td>20</td>
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<td>Aphasia Description (BDAE-3)</td>
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<td>Mixed</td>
<td>Mixed</td>
<td>Mixed</td>
<td>Conduction</td>
<td>Anomic</td>
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</table>
Note: participants arranged in order of PALPA 53 (Kay, et al., 1992) naming score.

* Test discontinued after 8 consecutive no responses.

**Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>PALPA</td>
<td>Psycholinguistic Assessment of Language Processing in Aphasia (Kay, Lesser, &amp; Coltheart, 1992)</td>
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<tr>
<td>BNT</td>
<td>Boston Naming Test (Kaplan, Goodglass, &amp; Weintraub, 1983)</td>
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<td>BDAE</td>
<td>Boston Diagnostic Aphasia Examination (Goodglass, Kaplan, &amp; Barresi, 2001)</td>
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<td>MCA</td>
<td>Middle cerebral artery</td>
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Table 4.2 Summary of results for language assessments

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<td>62.3 (1.6)</td>
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<td>-</td>
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<td>*0</td>
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<td>4</td>
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<td>32</td>
<td>18</td>
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**Emboldened** responses show normal performance *test discontinued after 10 consecutive no responses

Graded Naming Test (Warrington, 1997)

Synonym Judgement Task (Jefferies, Patterson, Jones & Lambon Ralph, 2009)

**Abbreviations**

P&P     Pyramids and Palm Trees (Howard & Patterson, 1992).
SWPM    Spoken word-to-picture match (Bozeat, et al., 2000)
WWPM    Written word-to-picture match (Bozeat, et al., 2000)
Reg     Regularity
Freq    Frequency
Img     Imageability
H       High
L       Low
## Table 4.3 Summary of results for cognitive assessment

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<tr>
<th>Participant</th>
<th>BR</th>
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<th>GH</th>
<th>AA</th>
<th>AD</th>
<th>EB</th>
<th>Control Mean (SD)</th>
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<td>Rey complex figure:</td>
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<td>990</td>
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<td>184</td>
<td>313</td>
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<td>11</td>
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<td>2.5</td>
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<td>4</td>
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<td>6.2 (1.3)</td>
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<tr>
<td>Corsi blocks</td>
<td>26 (75&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>24 (25&lt;sup&gt;th&lt;/sup&gt; - 50&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>23 (50&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>34 (95&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>20 (25&lt;sup&gt;th&lt;/sup&gt; - 50&lt;sup&gt;th&lt;/sup&gt;)</td>
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<td>Raven coloured matrices (percentile)</td>
<td>23 (40&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>15 (10&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>13 (5&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>30 (50&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>17 (20&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>25 (20&lt;sup&gt;th&lt;/sup&gt;)</td>
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<td>5 point test (percentiles):</td>
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<td>productivity</td>
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<td>6.67 (70&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>7.7 (60&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>13.4 (16&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>58.8 (&lt;2&lt;sup&gt;nd&lt;/sup&gt;)</td>
<td>11.53 (20)</td>
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<tr>
<td>flexibility</td>
<td>8.69 (40&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>13.34 (25&lt;sup&gt;th&lt;/sup&gt; - 30&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>15.38 (40)</td>
<td>30 (25)</td>
<td>1 (5&lt;sup&gt;th&lt;/sup&gt;-10&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>8 (5&lt;sup&gt;th&lt;/sup&gt;-10&lt;sup&gt;th&lt;/sup&gt;)</td>
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<td>strategy</td>
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<td>0 (5&lt;sup&gt;th&lt;/sup&gt;-100&lt;sup&gt;th&lt;/sup&gt;)</td>
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<td>2 (&lt;1&lt;sup&gt;st&lt;/sup&gt;)</td>
<td>1 (4&lt;sup&gt;th&lt;/sup&gt;)</td>
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</tr>
<tr>
<td>rule breaking</td>
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<td>6</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>5</td>
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<td>TEA: Elevator counting (with distraction)</td>
<td>1 (&lt;1&lt;sup&gt;st&lt;/sup&gt;)</td>
<td>3 (&lt;1&lt;sup&gt;st&lt;/sup&gt;)</td>
<td>5 (between 1&lt;sup&gt;st&lt;/sup&gt; &amp; 5&lt;sup&gt;th&lt;/sup&gt;)</td>
<td>7 (10&lt;sup&gt;th&lt;/sup&gt;)</td>
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<td>4 (1&lt;sup&gt;st&lt;/sup&gt;)</td>
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<td>&lt;5 = abnormal</td>
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75
Emboldened responses show normal performance

Rey complex figure (Meyers & Meyers, 1995)
Corsi block tapping (Kessels, van Zandvoort, Postma, Kappelle & de Haan, 2000)
Raven Coloured matrices (Raven, 1962)
5 Point Test (Goebel, Fischer, Ferstl, & Mehdorn, 2008)

Abbreviations
TEA  Test of Everyday Attention (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994)
4.2. **Summary of assessment findings**

1. **BR**

BR’s naming was markedly impaired - indicated by a score of 6/40 on the screening test PALPA 53 (Kay, et al., 1992) and 6/64 on the 64 Item Naming Test (Bozeat, Lambon Ralph, Patterson, Garrard & Hodges, 2000). Semantics and phonology were also impaired on all assessments. For semantics, he scored 43/52 for Pyramids and Palm Trees and 60/96 for the synonym judgement task, where his scores indicated an influence of imageability ($\chi^2 = 7.47$, df2, $p = 0.024$) but no frequency effect ($\chi^2 = 0.4$, df1, $p = 0.529$). For phonology, he was impaired on all tasks scoring lowest on the manipulation task: subtraction subtest (1/48) and highest for immediate word repetition (42/48). He presented with impairment in reading (74/96 on test of words varying by frequency and regularity and 42/48 on the test of words varying by imageability). His scores did not indicate an influence of imageability or frequency but they did indicate an influence of regularity ($\chi^2 = 4.53$, df1, $p = 0.033$). Spelling was markedly impaired on all word tasks (7/96 for Spelling to Dictation of words varying in imageability and frequency and 9/48 for words varying on spelling regularity). He scored within normal limits for spoken letter written matching. Spelling errors throughout the study were typically regularisation errors.

For memory, he performed within 2SD for accuracy and timing of reproduction for the Rey complex figure at immediate recall but was impaired at delayed recall. He was impaired on both the verbal short-term memory task (digit span) but within 2SD for the visuo-spatial short-term memory task (Corsi block tapping). On the executive functioning tests, BR performed at the 75th percentile for Raven Coloured Progressive Matrices but below the 50th percentile on the 4 aspects of the 5 Point Test. He was impaired on the distraction subtest of divided attention (<1st percentile).
2. **RW**

Naming was impaired for RW as shown by a score of 10/40 on the PALPA 53 screening test (Kay, et al., 1992) and 8/64 on the 64 Item Naming Test (Bozeat, Lambon Ralph, Patterson, Garrard & Hodges, 2000). She was also markedly impaired on all semantic and phonological assessments. Within semantics, she scored 31/64 for SWPM and 44/64 for WWPM with 43/52 for P&P and 63/96 for synonym judgement. On the synonym judgement task her scores indicated an influence of imageability ($\chi^2 = 8.59, df2, p = 0.014$) but no frequency effect ($\chi^2 = 0.4, df1, p = 0.529$). For phonology, she was impaired on all tasks, scoring lowest on the manipulation task: subtraction subtest (1/48) and highest for immediate word repetition (41/48). Her reading and spelling were markedly impaired with all single word reading and spelling to dictation assessments discontinued after 10 consecutive no responses. For memory, she performed within 2SD for accuracy of reproduction for the Rey complex figure at immediate recall but was impaired at delayed recall for both accuracy and timing. She was impaired on both the verbal short-term memory task but within 2SD for the visuo-spatial short-term memory task. On the executive functioning tests, she performed between the 25th-50th percentile for Raven Coloured Progressive Matrices and below the 50th percentile for 3 of 4 aspects of the 5 Point Test – for flexibility she performed at the 60th percentile. Her performance was also impaired on both subtests of attention with (<1st percentile).

3. **GH**

For GH, naming was impaired – he scored 20/40 on the PALPA 53 screening test (Kay, et al., 1992) and 15/64 on the 64 Item Naming Test (Bozeat, Lambon Ralph,
Patterson, Garrard & Hodges, 2000). He was impaired on all of the semantic and phonological tests. Within semantics, he scored 46/64 for WWPM and 42/96 on the synonym judgement task where his scores did not indicate an influence of either imageability ($\chi^2 = 1.02, df2, p = 0.602$) or frequency ($\chi^2 = 0.103, df1, p = 0.310$).

Within phonology, he failed to score on delayed word repetition and only 1/48 for the manipulation task: subtraction subtest but performed well at immediate word repetition (40/48). His reading and spelling were markedly impaired with all single word reading and spelling to dictation assessments discontinued after 10 consecutive no responses (spelling errors throughout the study were consistently neologistic).

There were no evident lexical variable effects throughout the background assessments.

For memory, he was impaired for accuracy and timing at both immediate and delayed recall of the Rey complex figure. He was also impaired on both the verbal short-term memory task (digit span) and the visuo-spatial short-term memory task. On the executive functioning tests, he was at the 50th percentile for Raven Coloured Progressive Matrices and below the 50th percentile for 3 of 4 aspects of the 5 Point Test – for flexibility he performed at the 70th percentile. His performance was impaired on both subtests of attention (<1st percentile).

4. AA

AA’s naming was impaired as indicated by a score of 15/40 on the screening test PALPA 53 (Kay, et al., 1992) and 28/64 on the 64 Item Naming Test (Bozeat, Lambon Ralph, Patterson, Garrard & Hodges, 2000). She presented with a mixed profile across semantics; scoring poorly on Pyramids and Palm Trees (40/52) yet more highly (76/96) for the more complex synonym judgement task (although still
impaired), where her scores indicated an influence of imageability ($\chi^2 = 15.6$, df2, $p < 0.001$) but not frequency ($\chi^2 = 0.56$, df1, $p = 0.453$). For phonology, she was near ceiling for immediate word repetition (47/48) but scored 8/48 for the addition subtest of the phonological manipulation test (she declined to be assessed on the subtraction subtest). For word reading she performed close to ceiling for words varying on reading regularity and frequency (94/96) and for words varying on imageability (44/48). Her scores did not indicate the influence of reading regularity, frequency or imagability. She performed more poorly for non-word reading (19/42). AA did score within normal limits for spoken letter written matching (25/26) and letter discrimination (59/60) however her spelling was impaired. For spelling to dictation she scored 34/96 for words varying on spelling frequency and imageability and 32/48 for words varying on spelling regularity. Her scores did not indicate the influence of imagability ($\chi^2 = 0.05$, df1, $p = 0.832$), frequency or imageability.

For memory, she was impaired for accuracy and timing at both immediate and delayed recall of the Rey complex figure. She was also impaired on both the verbal short-term memory task (digit span) but within 2SD for the visuo-spatial short-term memory task. On the executive functioning tests, she performed well on the Raven Coloured Progressive Matrices with a score above the 90th percentile, but below the 50th percentile on all aspects of the 5 Point Test. AA was within normal limits on the sustained attention subtest but at the 10th percentile for the divided attention subtest.

5. **AD**

Naming was impaired for AD as indicated by a score of 19/40 on the screening test PALPA 53 (Kay, et al., 1992) and 33/64 on the 64 Item Naming Test (Bozeat, Lambon Ralph, Patterson, Garrard & Hodges, 2000). For semantics, she scored 42/52
on P&P and 72/96 on the synonym judgment task, where her scores indicated an influence of imageability ($\chi^2 = 9.00, \text{df}2, p = 0.011$) but not frequency ($\chi^2 = 0.49, \text{df}1, p = 0.482$). Her phonology was impaired – lowest performance was for delayed non-word repetition (11/48) with highest performance for delayed word repetition (35/48). Both reading and spelling were also impaired. In reading aloud she scored 61/96 on words varying on reading frequency and regularity and 30/48 on words varying on imageability. Her scores did not indicate the influence of frequency ($\chi^2 = 0.71, \text{df}1, p = 0.399$), regularity or imageability. Spelling was markedly impaired (9/96 on words varying on spelling frequency and imaginability and 9/48 on words varying on spelling regularity). Her scores in spelling to dictation did not indicate the influence of imaginability (FET 2 tailed, $p = 0.818$), frequency or regularity (FET 2 tailed, $p = 0.232$).

For memory, she was impaired for accuracy at both immediate and delayed recall of the Rey complex figure; timing of reproduction was within 2 SD at immediate recall but outside 2SD at delayed recall. She was also impaired on both the verbal short-term memory task (digit span) but within 2SD for the visuo-spatial short-term memory task. On the executive functioning tests, she scored between the 25-50$^{th}$ percentile on the Raven Coloured Progressive Matrices with, and below the 20$^{th}$ percentile on all 4 aspects of the 5 Point Test. In terms of attention, she was impaired on both subtests.

6. **EB**

EB displayed a naming impairment as demonstrated by a score of 24/40 on PALPA 53 (Kay, et al., 1992) and 54/64 on the 64 Item Naming Test (Bozeat, Lambon Ralph, Patterson, Garrard & Hodges, 2000). Because she scored above 75% (48) on the 64
Item Naming Test, she was assessed on a more challenging naming test - the Graded Naming Test (Warrington, 1997) – where she scored of 2/30. She performed close to normal range for all semantic tests except for synonym judgement (66/96) where her scores indicated an influence of imageability ($\chi^2 = 36.07, \text{df}2, p < 0.001$) and frequency ($\chi^2 = 5.81, \text{df}1, p = 0.016$).

For phonology, she was somewhat impaired but she was at ceiling on auditory rhyme judgement. Her reading and spelling were impaired. In reading, she scored 78/96 on words varying in reading frequency and regularity and 34/48 on words varying in imageability. Her scores did not indicate an influence of regularity, frequency ($\chi^2 = 3.32, \text{df}1, p = 0.069$) or imageability. In spelling to dictation, she scored 21/96 on words varying on spelling frequency and imagability and 24/48 on words varying on spelling regularity. Her scores indicated an influence of imageability ($\chi^2 = 6.03, \text{df}1, p = 0.014$) but not frequency ($\chi^2 = 0.24, \text{df}1, p = 0.623$) or regularity.

For memory, she was not impaired for accuracy when copying the Rey complex figure but performance was impaired for accuracy and timing at both immediate and delayed recall of the figure. She was impaired on the verbal short-term memory task but within 2SD on the visuo-spatial short-term memory task. On the executive functioning tests, it was not possible to comment on her performance compared to normative data for the Raven Coloured Progressive Matrices as norms were not provided for her age. She performed below the 20th percentile on all 4 aspects of the 5 Point Test. In terms of attention, EB was within normal limits on the sustained attention subtest but impaired on the divided attention subtest.
Chapter 5

Results

5.1 Analysis

The research aims were to (1) determine the relative effects of an Item Focused (multimodal) therapy compared to a Task Focused (unimodal) therapy upon naming accuracy; (2) determine the effects of Item Focused and Task Focused therapy upon naming immediately after therapy and at one month follow-up; (3) examine any effects of the Item Focused therapy and the Task Focused therapy upon other language tasks not directly targeted by the therapy: repetition, spelling to dictation and reading aloud, and (4) determine any effects of Item Focused and Task Focused therapy upon repetition, spelling to dictation and reading aloud immediately after therapy and at 1 month follow-up.

To address these aims, analysis of the data examined performance at the level of the individual between and within each therapy type, immediately and 1 month after therapy, for the primary outcome measure of naming, using McNemar and Chi Squared tests were appropriate. The same analyses were conducted for the secondary outcome measures of repetition, spelling to dictation and reading aloud. Furthermore, group level analysis was carried out for the single language tasks and as a combined measure (termed ‘additional language skill’), using ANOVAs. In addition, group level analysis was also carried out to determine whether there was any significant interaction between treatment and post-therapy assessment phase using 2 way ANOVAs. Control data was also examined at both levels to determine whether significant effects were due to therapy and if generalisation could be attributed to either, or both, therapy. Finally, descriptive analysis was conducted to examine
whether either therapy had an effect on the type of errors produced during the four stated language tasks.

5.2 Treated Items

5.2.1 Individual effect of IF and TF therapy upon Naming of Treated Items

Raw scores for the Item Focused (multimodal) and Task Focused (unimodal) therapy for naming are provided below in Table 5.1 (baseline was zero). The scores provided in brackets are the number of nouns (n =) and verbs (v =) correct.

Table 5.1 Naming raw scores for IF and TF therapy (max n = 30, nouns = 20, verbs = 10)

<table>
<thead>
<tr>
<th>Therapy Group*</th>
<th>Baseline IF therapy</th>
<th>Baseline TF therapy</th>
<th>Post IF therapy</th>
<th>Post TF therapy</th>
<th>Follow-up IF therapy</th>
<th>Follow-up TF therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>2</td>
<td>0</td>
<td>9 (n6, v3)</td>
<td>22 (n16, v6)</td>
<td>15 (n11, v4)</td>
<td>2 (n2)</td>
</tr>
<tr>
<td>RW</td>
<td>1</td>
<td>0</td>
<td>6 (n1, v5)</td>
<td>9 (n6, v3)</td>
<td>5 (n2, v3)</td>
<td>7 (n6, v1)</td>
</tr>
<tr>
<td>GH</td>
<td>2</td>
<td>0</td>
<td>17 (n11, v6)</td>
<td>17 (n12, v5)</td>
<td>14 (n8, v6)</td>
<td>12 (n8, v4)</td>
</tr>
<tr>
<td>AA</td>
<td>2</td>
<td>0</td>
<td>26 (n17, v9)</td>
<td>26 (n17, v9)</td>
<td>19 (n13, v6)</td>
<td>24 (n15, v9)</td>
</tr>
<tr>
<td>AD</td>
<td>1</td>
<td>0</td>
<td>15 (n13, v2)</td>
<td>8 (n7, v1)</td>
<td>16 (n11, v5)</td>
<td>11 (n9, v2)</td>
</tr>
<tr>
<td>EB</td>
<td>1</td>
<td>0</td>
<td>22 (n17, v5)</td>
<td>21 (n16, v5)</td>
<td>24 (n16, v8)</td>
<td>23 (n16, v7)</td>
</tr>
</tbody>
</table>

* Therapy Group: Group 1 first received the IF therapy, followed by the TF therapy, whilst Group 2 initially received the TF therapy and then the IF therapy

For the Item Focused therapy (Table 5.1 and Fig. 5.1), all participants made highly significant improvements in their naming of treated items at immediate post therapy testing (AA, AD, GH and EB: McNemar, 2 tailed, p < 0.001; BR: McNemar, 2 tailed, p = 0.0039 and RW: McNemar 2 tailed, p = 0.0313), with 5 of the participants (AA, BR, GH and EB: McNemar, 2 tailed, p < 0.001; RW: McNemar 2 tailed, p = 0.039 and AD: McNemar, 2 tailed, p = 0.078) performing similarly for the Task Focused
therapy (Table 5.1 and Fig. 5.1). The improvements were still significant at follow-up for all participants receiving the IF therapy, except RW (AA, AD, BR, GH and EB: McNemar, 2 tailed, p < 0.001; RW: McNemar 2 tailed, p = 0.0625). Five participants (AA, AD, GH, EB: McNemar, 2 tailed, p < 0.001 and RW: McNemar, 2 tailed, p = 0.0156) also demonstrated significant improvements over baseline at follow-up testing for the TF therapy; BR was the only participant to show a significant decline between immediate post testing and follow-up (McNemar, 2 tailed, p < 0.0001).

![Graph showing results of IF and TF therapy](image)

**Fig. 5.1 Results of the IF and TF therapy upon naming immediately after therapy and at 1-month follow-up (percentage change)**

BR was the only participant who demonstrated a significant difference between the 2 therapies, at both post therapy time points. Immediately after therapy (Table 5.1 and Fig. 5.2), BR demonstrated significantly improved naming accuracy after the Task Focused therapy compared to the Item Focused ($\chi^2 = 11.3$, df1, $p < 0.0001$) but the outcome reversed at 1-month follow-up ($\chi^2 = 10.7$, df1, $p < 0.0001$) in favour of the
IF therapy (Table 5.1 and Fig. 5.2). RW and AA also displayed a greater improvement in accuracy of naming immediately after the TF therapy, and at follow-up, but the differences were not significant (RW: Immediate: $\chi^2 = 0.8$, df1, $p = 0.371$ and 1 month: $\chi^2 = 0.417$, df1, $p = 0.519$ & AA: Follow up: $\chi^2 = 2.052$, df1, $p = 0.152$).

In contrast, AD and EB demonstrated improved accuracy scores after the IF therapy at both time points. Although AD’s score reached near significance immediately after therapy (AD: $\chi^2 = 3.45$, df1, $p = 0.063$), EB did not (EB: $\chi^2 = 11.3$, df1, $p = 0.754$) and this was also true 1 month later (AD: $\chi^2 = 1.68$, df1, $p = 0.194$ and EB: $\chi^2 = 10.7$, df1, $p = 0.755$). The remaining participant (GH) did not display any difference between the therapies.

![Fig. 5.2 Percentage difference between IF and TF therapy upon naming immediately after therapy and at 1 month follow-up](image)

**5.2.2 The Effect of naming therapy upon Repetition of Treated Items**

*Table 5.2 Repetition raw scores for IF and TF therapy (max n = 30, nouns = 20, verbs = 10)*
All but 2 participants’ scores (AD and EB) were near or at ceiling for this task therefore they could not be expected to have improved significantly at any time point after either therapy (Table 5.2 and Fig. 5.3).

AD and EB’s improvements were significant from baseline to immediate post-therapy testing for the IF therapy (AD: McNemar, 2 tailed, $p = 0.0313$ and EB: McNemar, 2 tailed, $p = 0.0078$) and at follow-up, as the accuracy decreases were not significant (AD: McNemar, 2 tailed, $p = 0.5$ and EB: McNemar, 2 tailed, $p = 0.5$). In contrast, neither participant’s scores significantly improved either immediately after the TF therapy (AD: McNemar, 2 tailed, $p = 0.5$ and EB: McNemar, 2 tailed, $p = 0.238$) or at follow-up (AD: McNemar, 2 tailed, $p = 0.238$ and EB: McNemar, 2 tailed, $p = 1$).
EB was also the only participant who displayed greater accuracy immediately after the TF therapy compared to the IF therapy (Fig. 5.4), which approached significance ($\chi^2 = 1.02$, df1, $p = 0.095$). The reverse pattern was displayed at follow up after the IF therapy but did not reach difference significance (EB: $\chi^2 = 0.218$, df1, $p = 0.64$), unlike RW’s performance ($\chi^2 = 4.29$, df1, $p = 0.038$) immediately after the IF therapy ($\chi^2 = 4.29$, df1, $p = 0.038$) compared to the TF therapy.
5.2.3 The Effect of naming therapy upon Spelling to Dictation of Treated Items

Table 5.3 Spelling to Dictation raw scores for IF and TF therapy (max n = 30, nouns = 20, verbs = 10)

<table>
<thead>
<tr>
<th>Therapy Group*</th>
<th>Baseline IF therapy</th>
<th>Baseline TF therapy</th>
<th>Post IF therapy</th>
<th>Post TF therapy</th>
<th>Follow-up IF therapy</th>
<th>Follow-up TF therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>2</td>
<td>5 (n5)</td>
<td>10 (n9, v1)</td>
<td>19 (n13, v6)</td>
<td>20 (n14, v6)</td>
<td>16 (n13, v3)</td>
</tr>
<tr>
<td>RW</td>
<td>1</td>
<td>3 (n3)</td>
<td>0</td>
<td>7 (n5,v2)</td>
<td>5 (n5)</td>
<td>7 (n6,v1)</td>
</tr>
<tr>
<td>GH</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AA</td>
<td>2</td>
<td>26 (n16, v10)</td>
<td>25 (n16, v9)</td>
<td>28 (n18, v10)</td>
<td>22 (n16, v6)</td>
<td>27 (n19, v8)</td>
</tr>
<tr>
<td>AD</td>
<td>1</td>
<td>12 (n9, v3)</td>
<td>13 (n9, v4)</td>
<td>8 (n6,v2)</td>
<td>11 (n8, v3)</td>
<td>14 (n11,v3)</td>
</tr>
<tr>
<td>EB</td>
<td>1</td>
<td>9 (n8, v1)</td>
<td>14 (n12, v2)</td>
<td>23 (n16, v7)</td>
<td>17 (n13, v4)</td>
<td>23 (n16, v7)</td>
</tr>
</tbody>
</table>

NB: Italicised responses indicate those near ceiling. * Therapy Group: Group 1 first received the IF therapy, followed by the TF therapy, whilst Group 2 initially received the TF therapy and then the IF therapy.

AA’s scores were near ceiling for these tasks therefore were not expected to improve significantly at any time point after either therapy (Table 5.3 and Fig. 5.5). The spelling to dictation scores for GH did not improve from a baseline of 0 (with constant neologistic error) at any time point.

Three participants (BR, RW and EB) demonstrated an improvement from baseline in the spelling to dictation of items treated with Item Focused naming therapy (Table 5.3 and Fig. 5.5), with BR and EB displaying significant results (BR: McNemar, 2 tailed, p = 0.001 and EB: McNemar, 2 tailed, p = 0.001). The performances of the 2 participants were maintained at follow-up (BR: McNemar, 2 tailed, p = 0.0625 and EB: McNemar, 2 tailed, p = 0.5). Both participants again had improved accuracy.
scores from baseline to immediate post-testing following the Task Focused naming therapy, but only BR’s result was significant (BR: McNemar, 2 tailed, p = 0.002 and EB: McNemar, 2 tailed, p = 0.25) – an improvement BR maintained at follow-up, as the drop in score was not significant (McNemar, 2 tailed, p = 0.625).

Two participants demonstrated falls in accuracy between baseline and post-testing: AD for both therapies and RW for the TF therapy. Neither of AD’s accuracy decreases were significant (IF post-therapy: McNemar, 2 tailed, p = 0.0625 and TF post therapy: McNemar, 2 tailed, p = 0.38) but RW’s performance was significant (RW: McNemar, 2 tailed, p = 0.031). At follow-up, AD’s improved score following the IF therapy was not significant (follow-up: McNemar, 2 tailed, p = 0.5) and performance remained unaltered between immediate and follow up testing for the TF therapy, whilst RW’s improvement 1 month after the TF therapy remained (McNemar, 2 tailed, p = 0.015)

Fig. 5.5 Effect of IF and TF therapy on Spelling to Dictation at baseline, immediately after therapy and at 1-month follow-up (percentage change)
When the 2 therapies scores were directly compared immediately after therapy and at 1 month later, AD and EB demonstrated significantly improved accuracy of spelling (AD: $\chi^2 = 4.32$, df1, $p = 0.038$ and $\chi^2 = 5.33$, df1, $p = EB: 0.019$) following the IF therapy (Table 5.3 and Fig. 5.6). There were no significant differences at any time point between the 2 therapies for the remaining 3 participants (all McNemars between $p = .1$ and $.5$).

![Figure 5.6 Percentage difference between IF and TF therapy on spelling to dictation immediately after therapy and at follow-up](image)

**Participants**

*Fig. 5.6 Percentage difference between IF and TF therapy on spelling to dictation immediately after therapy and at follow-up*

### 5.2.4 The Effect of naming therapy upon Reading Aloud of Treated Items

*Table 5.4 Reading Aloud raw scores for IF and TF therapy (max $n = 30$, nouns $= 20$, verbs $= 10$)*

<table>
<thead>
<tr>
<th>Therapy Group*</th>
<th>Baseline IF therapy</th>
<th>Baseline TF therapy</th>
<th>Post IF therapy</th>
<th>Post TF therapy</th>
<th>Follow-up IF therapy</th>
<th>Follow-up TF therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>2</td>
<td>22 (n15, v7)</td>
<td>23 (n16, v7)</td>
<td>23 (n17, v6)</td>
<td>26 (n18, v8)</td>
<td>30 (n16, v6)</td>
</tr>
<tr>
<td>RW</td>
<td>1</td>
<td>3 (n3)</td>
<td>3 (n2, v1)</td>
<td>7 (n4, v3)</td>
<td>16 (n11, v5)</td>
<td>7 (n4, v3)</td>
</tr>
<tr>
<td>GH</td>
<td>2</td>
<td>9 (n6, v3)</td>
<td>9 (n8, v1)</td>
<td>21 (n15, v6)</td>
<td>21 (n17, v4)</td>
<td>21 (n14, v7)</td>
</tr>
<tr>
<td>AA</td>
<td>2</td>
<td>28 (n20, v8)</td>
<td>27 (n19, v8)</td>
<td>27 (n20, v7)</td>
<td>30 (n19, v9)</td>
<td>29 (n19, v10)</td>
</tr>
</tbody>
</table>
AA’s scores were near ceiling for this task and therefore were not expected to improve significantly at any time point after either therapy (Table 5.4 and Fig. 5.7).

4 participants (BR, RW, GH and EB) demonstrated improved reading aloud scores of treated items from baseline to immediately post-testing for both therapies (Table 5.4 and Fig. 5.7). Yet, the increased scores only reached significance for GH and EB after both therapies, (GH IF: McNemar, 2 tailed, p = 0.001; GH TF: McNemar, 2 tailed, p = 0.005; EB IF: McNemar, 2 tailed, p = 0.031 and EB TF: McNemar, 2 tailed, p = 0.031) and for RW after the TF therapy (McNemar, 2 tailed, p = 0.002). Improved performance one month after each therapy was also significantly maintained for both GH and EB (GH IF: McNemar, 2 tailed, p = 0.008; GH TF: McNemar, 2 tailed, p = 0.005; EB IF: McNemar, 2 tailed, p = 0.0156 and EB TF: McNemar, 2 tailed, p = 0.313). BR alone displayed a significant improvement between immediate and follow-up testing for the IF therapy to reach ceiling (McNemar, 2 tailed, p = 0.0156) whilst displaying a fall in accuracy to below baseline a month after the TF therapy (McNemar, 2 tailed, p = 0.25). A significant fall to near baseline was also evident for RW at follow-up for the TF therapy (McNemar, 2 tailed, p = 0.002).
Fig. 5.7 Effect of Item Focused and Task Focused therapy on Reading Aloud at baseline, immediately after therapy and at 1-month follow-up (percentage change)

Despite 4 participants (BR, RW, GH and EB) showing greater improvement immediately after (Fig. 5.8) the Task Focused therapy compared to the Item Focused therapy, the difference was only significant for RW ($\chi^2 = 5.71$, df1, $p = 0.017$). Three of these participants (BR, RW and EB) however displayed the converse pattern at follow up, with greater accuracy following the IF therapy compared to the Task Focused therapy, but the result was only significant for BR ($\chi^2 = 5.71$, df1, $p = 0.017$). AD and AA’s immediate performance improved after the IF therapy compared to the TF therapy, with AD maintaining improved performance whilst AA showed greater improved 1 month after the TF therapy. Yet, none of the differences between the therapies were significant for these 2 participants at any time point (Follow up: AA: $\chi^2 = 3.16$, df1, $p = 0.076$ and AD: $\chi^2 = 1.09$, df1, $p = 0.297$).
5.2.5 Group Analysis for the effect of therapy upon treated items for Repetition, Spelling to Dictation and Reading Aloud and as an Additional Language Skill

Further analysis of naming therapy upon, repetition, spelling to dictation and reading aloud of treated items was conducted to see whether any therapeutic difference was evident between the two therapies at different time points if individual task scores were collated and compared for each task in turn, and, as a cumulative skill set for the group.

Table 5.5 summarises the number of significant improvements over baseline that are evident for each of the 2 therapy types immediately post therapy and at follow up across the group for each language task and overall ability.

![Chart showing percentage accuracy by participants for different therapies and tasks](chart.png)

**Participants**

*Fig. 5.8 Difference between IF and TF therapy upon Reading Aloud immediately and 1-month after therapy*

<table>
<thead>
<tr>
<th></th>
<th>Naming (n=6)</th>
<th>Repetition (n=6)</th>
<th>Spelling (n=6)</th>
<th>Reading (n=6)</th>
<th>Cumulative Tasks (n=36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RW</td>
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<td>GH</td>
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<td>AA</td>
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<tr>
<td>EB</td>
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</tr>
<tr>
<td>group average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.5 Number of collated individual and overall significant improvements for language tasks immediately after therapy and at follow-up for both IF and TF therapies
The collated scores for each of the 4 individual language tasks (naming, repetition, spelling to dictation and reading aloud) did not display results that were likely to be significant at either time point between the two therapies. Statistical analysis was therefore not conducted for any of the single language tasks. When the tasks were analysed as a combined skills set, the raw scores showed that the IF therapy resulted in a greater number of significant improvements immediately after therapy and at follow-up compared to the TF therapy. Analysis demonstrated however that the difference was not significant at either time point (Post-therapy: \( \chi^2 = 0.33, \text{df}1, p = 0.565 \) and Follow-up: \( \chi^2 = 0.76, \text{df}1, p = 0.385 \)).

<table>
<thead>
<tr>
<th>Item Focused</th>
<th>Post therapy</th>
<th>Follow-up</th>
<th>Post therapy</th>
<th>Follow-up</th>
<th>Post therapy</th>
<th>Follow-up</th>
<th>Post therapy</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Correct</td>
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<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Total Incorrect</td>
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<td>1</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>24</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Task Focused</th>
<th>Post therapy</th>
<th>Follow-up</th>
<th>Post therapy</th>
<th>Follow-up</th>
<th>Post therapy</th>
<th>Follow-up</th>
<th>Post therapy</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Correct</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Total Incorrect</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>27</td>
</tr>
</tbody>
</table>

5.2.6 Group effect of therapy upon Repetition, Spelling to Dictation and Reading Aloud for Treated and Control Items

There was no significant difference in the repetition, spelling to dictation or reading aloud of treated items immediately post-testing (repetition: \( t[5] = 2.584, p = 0.56 \); spelling: \( t = 1.096, \text{df}5, p = 0.323 \) and reading: \( t = 0.815, \text{df}5, p = 0.41 \)) or at follow-up (repetition: \( t[5] = 1.052, p = 0.34 \); spelling \( t = 2.51, \text{df}5, p = 0.41 \) and reading: \( t = 1.729, \text{df}5, p = 0.108 \)) for the group. Similarly, there was no significant difference upon the repetition, spelling to dictation and reading aloud of control items between the 2 therapies immediately after therapy (repetition: \( t = 2.62, \text{df}5, p = 0.745 \); spelling: \( t = 2.05, \text{df}5, p = 0.63 \)).
$t = 2.62$, df5, $p = 0.278$ and reading: $t = 2.02$, df5, $p = 0.695$) or at follow-up (repetition: $t = 0.275$, df5, $p = 0.21$; spelling: $t = 0.275$, df5, $p = 0.197$ and reading: $t = 0.275$, df5, $p = 0.42$).

5.2.7 Group difference between treatment types and post-treatment testing phase

Analysis of both the Item and Task focused therapies across the post-testing time points was conducted for treated items so identify whether any evident difference in naming performance across the two therapies and post-testing time points for the group. The comparative differences were analysed using 2 way ANOVAs.

Analysis indicates that there was no significant interaction between therapy type and the post-treatment testing phase for the group’s naming performance (Table 5.6).

Table 5.6 Results for interaction between treatment and post-therapy testing for naming

<table>
<thead>
<tr>
<th>Naming</th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr (&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapy</td>
<td>1</td>
<td>30.375</td>
<td>30.375</td>
<td>0.556</td>
<td>0.464</td>
</tr>
<tr>
<td>Phase</td>
<td>1</td>
<td>9.375</td>
<td>9.375</td>
<td>0.172</td>
<td>0.683</td>
</tr>
<tr>
<td>Therapy Phase Interaction</td>
<td>1</td>
<td>0.375</td>
<td>0.375</td>
<td>0.007</td>
<td>0.935</td>
</tr>
<tr>
<td>Residuals</td>
<td>20</td>
<td>1091.8</td>
<td>54.592</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig. 5.9 Number of collated individual and overall significant improvements for language tasks immediately after therapy and at follow-up for both IF and TF therapies (I = Item Focused therapy, T = Task Focused therapy, P = Immediate post therapy and F = follow up).

There was also no significant interaction between therapy types and the post-treatment testing phase for evident for repetition performance (Table 5.7), spelling to dictation (Table 5.8) or reading aloud (Table 5.9) for the group.

Table 5.7 Results for interaction between treatment and post-therapy testing for group repetition

<table>
<thead>
<tr>
<th>Repetition</th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr (&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapy</td>
<td>1</td>
<td>10.667</td>
<td>10.667</td>
<td>0.428</td>
<td>0.52</td>
</tr>
<tr>
<td>Phase</td>
<td>1</td>
<td>2.667</td>
<td>2.667</td>
<td>0.107</td>
<td>0.747</td>
</tr>
<tr>
<td>Therapy Phase Interaction</td>
<td>1</td>
<td>24</td>
<td>24</td>
<td>0.964</td>
<td>0.338</td>
</tr>
<tr>
<td>Residuals</td>
<td>20</td>
<td>498</td>
<td>24.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.8 Results for interaction between treatment and post-therapy testing for group spelling to dictation

<table>
<thead>
<tr>
<th>Spelling to Dictation</th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr (&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapy</td>
<td>1</td>
<td>3.375</td>
<td>3.375</td>
<td>0.037</td>
<td>0.85</td>
</tr>
<tr>
<td>Phase</td>
<td>1</td>
<td>1.042</td>
<td>1.042</td>
<td>0.011</td>
<td>0.916</td>
</tr>
<tr>
<td>Therapy Phase Interaction</td>
<td>1</td>
<td>1.042</td>
<td>1.042</td>
<td>0.011</td>
<td>0.916</td>
</tr>
<tr>
<td>Residuals</td>
<td>20</td>
<td>1845.5</td>
<td>92.275</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.9 Results for interaction between treatment and post-therapy testing for group reading aloud

<table>
<thead>
<tr>
<th>Reading</th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr (&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Therapy</td>
<td>1</td>
<td>48.167</td>
<td>48.167</td>
<td>0.667</td>
<td>0.424</td>
</tr>
<tr>
<td>Phase</td>
<td>1</td>
<td>2.667</td>
<td>2.667</td>
<td>0.037</td>
<td>0.85</td>
</tr>
<tr>
<td>Therapy Phase Interaction</td>
<td>1</td>
<td>48.167</td>
<td>48.167</td>
<td>0.667</td>
<td>0.424</td>
</tr>
<tr>
<td>Residuals</td>
<td>20</td>
<td>1444.3</td>
<td>72.217</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.3 Control Items

Naming

Table 5.10 Control item raw scores for naming taken immediately and at follow-up for both IF and TF therapy (max n = 30, nouns = 20, verbs = 10)
<table>
<thead>
<tr>
<th>Therapy Group</th>
<th>Baseline control</th>
<th>Post IF control</th>
<th>Follow-up IF control</th>
<th>Post TF control</th>
<th>Follow-up TF control</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>2</td>
<td>0</td>
<td>4 (n2, v2)</td>
<td>5 (n5)</td>
<td>0</td>
</tr>
<tr>
<td>RW</td>
<td>1</td>
<td>0</td>
<td>1 (n1)</td>
<td>2 (n2)</td>
<td>3 (n2, v1)</td>
</tr>
<tr>
<td>GH</td>
<td>2</td>
<td>0</td>
<td>8 (n6, v2)</td>
<td>9 (n5, v1)</td>
<td>7 (n5, v2)</td>
</tr>
<tr>
<td>AA</td>
<td>2</td>
<td>0</td>
<td>11 (n9, v2)</td>
<td>9 (n7, v2)</td>
<td>11 (n10, v1)</td>
</tr>
<tr>
<td>AD</td>
<td>1</td>
<td>0</td>
<td>7 (n6, v1)</td>
<td>9 (n8, v1)</td>
<td>7 (n7)</td>
</tr>
<tr>
<td>EB</td>
<td>1</td>
<td>0</td>
<td>8 (n6, v2)</td>
<td>12 (n9, v3)</td>
<td>13 (n9, v4)</td>
</tr>
</tbody>
</table>

* Therapy Group: Group 1 first received the IF therapy, followed by the TF therapy, whilst Group 2 initially received the TF therapy and then the IF therapy

For control items (Table 5.10 and Fig. 5.7), 4 participants showed significant change from a zero baseline immediately after both the IF and TF therapies (GH IF: McNemar 2 tailed, p = 0.007 and TF: McNemar 2 tailed, p = 0.004; AA IF: McNemar 2 tailed, p = 0.001 and TF: McNemar 2 tailed, p = 0.004; AD IF: McNemar 2 tailed, p = 0.001 and TF: McNemar 2 tailed, p = 0.003; EB IF: McNemar 2 tailed, p = 0.007 and TF: McNemar 2 tailed, p = 0.001). All 4 maintained this at follow-up for the IF therapy (GH: McNemar 2 tailed, p = 1; AA: McNemar 2 tailed, p = 0.3438; AD: McNemar 2 tailed, p = 0.268 and EB: McNemar 2 tailed, p = 0.754) whilst 2 retained the improvement at follow-up after the TF therapy (GH: McNemar 2 tailed, p = 0.753; AA: McNemar 2 tailed, p = 0.555; AD: McNemar 2 tailed, p = 0.688 and EB: McNemar 2 tailed, p = 1). BR and RW did not demonstrate change at either time point after either therapy (all McNemars between p = .1 and .5).
**Fig. 5.8** Effect of Control items taken immediately after therapy and at 1-month follow-up for both IF and TF therapy

**Fig. 5.9** Percentage Average of Treated and Control items for Naming at baseline, immediately after therapy and at 1 month follow-up

**Repetition**
Table 5.11 Control item raw scores for repetition taken immediately and at follow-up for both IF and TF therapy (max n = 30, nouns = 20, verbs = 10)

<table>
<thead>
<tr>
<th>Therapy Group</th>
<th>Baseline control</th>
<th>Post IF control</th>
<th>Follow-up IF control</th>
<th>Post TF control</th>
<th>Follow-up TF control</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>2</td>
<td>29 (n19, v10)</td>
<td>24 (n16, v8)</td>
<td>26 (n16, v10)</td>
<td>27 (n18, v9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26 (n19, v7)</td>
</tr>
<tr>
<td>RW</td>
<td>1</td>
<td>29 (n19, v10)</td>
<td>26 (n18, v8)</td>
<td>23 (n14, v9)</td>
<td>27 (n18, v9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24 (n17, v7)</td>
</tr>
<tr>
<td>GH</td>
<td>2</td>
<td>26 (n18, v8)</td>
<td>21 (n15, v6)</td>
<td>18 (n14, v4)</td>
<td>22 (n16, v6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23 (n15, v8)</td>
</tr>
<tr>
<td>AA</td>
<td>2</td>
<td>30 (n15, v8)</td>
<td>27 (n17, v10)</td>
<td>27 (n19, v10)</td>
<td>29 (n18, v9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27 (n18, v9)</td>
</tr>
<tr>
<td>AD</td>
<td>1</td>
<td>13 (n9, v4)</td>
<td>13 (n11, v2)</td>
<td>18 (n12, v6)</td>
<td>14 (n10, v4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11 (n7, v4)</td>
</tr>
<tr>
<td>EB</td>
<td>1</td>
<td>19 (n12, v7)</td>
<td>18 (n13, v5)</td>
<td>20 (n13, v7)</td>
<td>25 (n18, v7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22 (n15, v7)</td>
</tr>
</tbody>
</table>

NB: Emboldened responses indicate maximum scores and italicised responses indicate those near ceiling.

Fig. 5.10 Results of Control items for repetition at baseline, immediately after therapy and at 1-month follow-up for IF and TF therapy

BR, GH and AA’s scores were near or at ceiling for this task therefore were not expected to show significant change at any time point. None of the remaining
participants (Table 5.11 and Fig. 5.10), demonstrated a significant effect immediately post testing (all McNemars between p = 1) or at follow-up for the IF or TF therapy (all McNemars between p = .1 and .5).

![Percentage Average of Treated and Control items for Repetition immediately after therapy and at 1-month follow-up](image)

**Spelling to Dictation**

Table 5.12 Control item raw scores for Spelling to Dictation taken immediately and at follow-up for both IF and TF therapy (max n = 30, nouns = 20, verbs = 10)

<table>
<thead>
<tr>
<th></th>
<th>Baseline control</th>
<th>Post IF control</th>
<th>Follow-up IF control</th>
<th>Post TF control</th>
<th>Follow-up TF control</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>10 (n9, v1)</td>
<td>11 (n6, v5)</td>
<td>15 (n10, v5)</td>
<td>13 (n10, v3)</td>
<td>5 (n3, v2)</td>
</tr>
<tr>
<td>RW</td>
<td>1 (n1)</td>
<td>3 (n3)</td>
<td>0</td>
<td>2 (n2)</td>
<td>2 (n2)</td>
</tr>
<tr>
<td>GH</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AA</td>
<td>24 (n16, v8)</td>
<td>24 (n16, v8)</td>
<td>24 (n16, v8)</td>
<td>17 (n14, v3)</td>
<td>26 (n16, v10)</td>
</tr>
<tr>
<td>AD</td>
<td>8 (n7, v1)</td>
<td>9 (n5, v4)</td>
<td>8 (n7, v1)</td>
<td>11 (n8, v3)</td>
<td>11 (n9, v2)</td>
</tr>
<tr>
<td>EB</td>
<td>8 (n7, v1)</td>
<td>14 (n8, v6)</td>
<td>9 (n6, v3)</td>
<td>17 (n10, v7)</td>
<td>16 (n10, v6)</td>
</tr>
</tbody>
</table>
For control items (Table 5.12 and Fig. 5.12), EB was the only participant to demonstrate a significant effect immediately after the IF and TF therapies for untreated items (IF: McNemar 2 tailed, p = 0.0313 and TF: McNemar 2 tailed, p = 0.002). The changes were retained at follow up, again following both therapies (IF: McNemar 2 tailed, p = 0.625 and TF: McNemar 2 tailed, p = 0.5). The decrease in score for AA at the same time point was significant (McNemar 2 tailed, p = 0.0313) for the TF therapy.

Fig. 5.12 Percentage Average of Treated and Control items for Spelling to Dictation at baseline, immediately after therapy and at 1-month follow-up.
Fig. 5.13 Results of Control items for Spelling to Dictation taken immediately after therapy and at 1-month follow-up for both IF and TF therapy

Reading Aloud

Table 5.13 Control item raw scores for Reading Aloud taken immediately and at follow-up for both IF and TF therapy (max n = 30, nouns = 20, verbs = 10)

<table>
<thead>
<tr>
<th>Therapy Group</th>
<th>Baseline control</th>
<th>Post IF control</th>
<th>Follow-up IF control</th>
<th>Post TF control</th>
<th>Follow-up TF control</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>2</td>
<td>24 (n17, v7)</td>
<td>23 (n16, v7)</td>
<td>26 (n16, v10)</td>
<td>20 (n15, v5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24 (n17, v7)</td>
</tr>
<tr>
<td>RW</td>
<td>1</td>
<td>6 (n4, v2)</td>
<td>2 (n2)</td>
<td>2 (n2)</td>
<td>8 (n6, v2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 (n6)</td>
</tr>
<tr>
<td>GH</td>
<td>2</td>
<td>6 (n6)</td>
<td>9 (n9)</td>
<td>9 (n8, v1)</td>
<td>10 (n8, v2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8 (n8)</td>
</tr>
<tr>
<td>AA</td>
<td>2</td>
<td>26 (n17, v9)</td>
<td>28 (n19, v9)</td>
<td>26 (n18, v8)</td>
<td>28 (n19, v9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28 (n18, v10)</td>
</tr>
<tr>
<td>AD</td>
<td>1</td>
<td>11 (n8, v3)</td>
<td>9 (n8, v1)</td>
<td>11 (n7, v4)</td>
<td>11 (n8, v3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 (n7, v3)</td>
</tr>
<tr>
<td>EB</td>
<td>1</td>
<td>22 (n14, v8)</td>
<td>15 (n11, v4)</td>
<td>21 (n15, v6)</td>
<td>22 (n13, v9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21 (n15, v6)</td>
</tr>
</tbody>
</table>

NB: Italicised responses indicate those near ceiling.
AA’s scores were again near ceiling for this task and therefore were not expected to demonstrate any change of significance at any time point after either therapy.

For the remaining participants (Table 5.13 and Fig. 5.14), no participant displayed significant improvement in reading aloud immediately after therapy or at follow-up for the IF or TF therapy. EB’s decrease in reading ability was significant (McNemar 2 tailed, p = 0.016).

Fig. 5.14 Results of Control items for Reading Aloud taken immediately after therapy and at 1-month follow-up for both IF and TF therapy
Comparative effect of naming therapy for Treated versus Control Items

As the individual control scores across all tasks were significantly above baseline, it was necessary to address whether the significant improvements of treated items were attributable to the therapy interventions. The significantly improved treated item scores for each language task where therefore compared with the corresponding significantly improved control item scores to determine if the differences were greater for treated items. The comparative differences were analysed using ANOVAs.

Comparative analysis of significant results for the naming of treated and control items for all participants showed that the group’s improvement of treated items was only attributable to the therapy immediately after intervention (ANOVA $F_{3,40} = 4.3316, p = 0.0166$). It was not attributable to therapy at follow-up (ANOVA $F_{3,40} = 1.5173, p = 0.241$). For repetition, analysis of the IF therapy significant results for treated and control items indicated the significant improvement in repetition of treated items of the 2 participants immediately after naming therapy (ANOVA, $F_{3,20} = 0.3759, p =$

![Figure 5.15 Percentage Average of Treated and Control items for Reading Aloud immediately after therapy and at 1-month](image-url)
0.771) and at follow-up (Fig. 5.20 ANOVA, F_{3.20} = 0.5208, p = 0.6729) was not attributable to the therapy. The result was replicated when comparing significant improvements in spelling to dictation of treated and control items for participant EB, thereby limiting the likelihood that the improvements evident in the treated items for both the IF and TF therapy at both assessment time points were as a direct result of the interventions (Immediate: ANOVA, F_{3.20} = 0.2664, p = 0.8488 and Follow-up: ANOVA, F_{3.20} = 0.2808, p = 0.8386). Similarly, for reading aloud, it was not possible to state that the improvements in reading aloud of treated items after both naming therapies at either time point were attributable to the interventions (Immediate: ANOVA, F_{3.20} = 0.8457, p = 0.4805 and Follow-up: ANOVA, F_{3.20} = 0.4833, p = 0.6976).

5.4 Error Analysis

Analysis of the error types produced by the participants was carried out to examine whether either therapy had an effect on the nature of errors produced in naming. The following definitions were used to categorise the errors: no response – omissions or partial responses; phonological - the response contained at least half of the phonemes found in the target in any order; semantic – circumlocution, superordinate, coordinate or subordinate responses; unrelated – a neologism or word that did not share any semantic or phonological information of the target word and mixed – e.g. a response that shared lexical information with the target. All errors presented are given as percentages of all errors at each assessment time point.
Participants BR and AD predominately produced one error type – phonological errors. For BR (Table 5.14), these errors remained unchanged for IF therapy at both assessment time points whilst for AD (Table 5.15), her phonological errors decreased immediately after therapy but returned to near baseline at follow-up. For the TF therapy, BR’s percentage of phonological errors increased at both assessment time points but remained unchanged for AD.

*Table. 5.14 Participant BR: Raw error scores in naming across assessment time points for Item and Task Focused therapies*

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Assessment Time Point</th>
<th>TF Baseline</th>
<th>TF Post-therapy</th>
<th>TF Follow-up</th>
<th>IF Baseline</th>
<th>IF Post-therapy</th>
<th>IF Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonological</td>
<td></td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Unrelated</td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total errors</td>
<td></td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

*Table. 5.15 Participant AD: Raw error scores in naming across assessment time points for Item and Task Focused therapies*

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Assessment Time Point</th>
<th>TF Baseline</th>
<th>TF Post-therapy</th>
<th>TF Follow-up</th>
<th>IF Baseline</th>
<th>IF Post-therapy</th>
<th>IF Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonological</td>
<td></td>
<td>17</td>
<td>16</td>
<td>12</td>
<td>19</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Unrelated</td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total errors</td>
<td></td>
<td>18</td>
<td>16</td>
<td>12</td>
<td>19</td>
<td>13</td>
<td>12</td>
</tr>
</tbody>
</table>

RW, GH, AA and EB produced a range of errors with typically 2 prominent error types. GH frequently produced no response and semantic errors (Table 5.16). At immediate post-therapy testing, the percentage of no response errors decreased for both therapies and increased at follow-up. His semantic errors decreased slightly at post-therapy testing but to zero at follow-up for the TF therapy. For the IF therapy, no semantics errors were produced at baseline but were produced at similar levels at post-therapy testing and follow-up.
Table. 5.16 Participant GH: Raw error scores in naming across assessment time points for Item and Task Focused therapies

<table>
<thead>
<tr>
<th>Error Type</th>
<th>TF Baseline</th>
<th>TF Post-therapy</th>
<th>IF Baseline</th>
<th>IF Post-therapy</th>
<th>IF Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Response</td>
<td>20</td>
<td>3</td>
<td>6</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>Phonological</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Semantic</td>
<td>9</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Unrelated</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>4</td>
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</tr>
<tr>
<td>Mixed</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total errors</strong></td>
<td><strong>30</strong></td>
<td><strong>13</strong></td>
<td><strong>11</strong></td>
<td><strong>30</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>

Similarly, EB typically produced phonological errors but also those semantic in nature (Table 5.17). Phonological errors increased at immediate post-therapy testing for both therapies, continuing to rise at follow-up for the IF therapy whilst falling to just below baseline for the TF therapy. In comparison, semantic errors decreased at immediate post-therapy testing for both therapies and were not produced at follow-up for the IF therapy (whilst rising back to baseline for the TF therapy).

Table. 5.17 Participant EB: Raw error scores in naming across assessment time points for Item and Task Focused therapies

<table>
<thead>
<tr>
<th>Error Type</th>
<th>TF Baseline</th>
<th>TF Post-therapy</th>
<th>IF Baseline</th>
<th>IF Post-therapy</th>
<th>IF Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Response</td>
<td>7</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Semantic</td>
<td>8</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Phonological</td>
<td>12</td>
<td>6</td>
<td>5</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Unrelated</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mixed</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total errors</strong></td>
<td><strong>30</strong></td>
<td><strong>9</strong></td>
<td><strong>7</strong></td>
<td><strong>30</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

AA also produced semantic errors and errors of no response at baseline (Table 5.18). Semantic errors noticeably increased immediately after therapy for TF therapy and were not produced at follow up whilst the IF therapy saw a slight increase from baseline to follow-up. There was a reduction in no response errors immediately after
therapy for both therapies but the percentages increased to above baseline at follow-up for the TF therapy.

Table 5.18 Participant AA: Raw error scores in naming across assessment time points for Item and Task Focused therapies

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Assessment Time Point</th>
<th>TF Baseline</th>
<th>TF Post-therapy</th>
<th>TF Follow-up</th>
<th>IF Baseline</th>
<th>IF Post-therapy</th>
<th>IF Follow-up</th>
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<tr>
<td>No Response</td>
<td>25</td>
<td>1</td>
<td>6</td>
<td>22</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Semantic</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Phonological</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
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<tr>
<td>Visual</td>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Unrelated</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
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<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
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<tr>
<td>Total errors</td>
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<td>4</td>
<td>6</td>
<td>30</td>
<td>4</td>
<td>11</td>
<td></td>
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</tbody>
</table>

RW also typically produced no response errors (Table 5.19). These decreased immediately post-therapy for both therapies but to a greater extent for the IF therapy. The no response errors increased back to near baseline for at follow-up for IF, whilst they continued to decline at follow-up for the TF therapy.

Table 5.19 Participant RW: Raw error scores in naming across assessment time points for Item and Task Focused therapies

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<th>Error Type</th>
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<th>TF Baseline</th>
<th>TF Post-therapy</th>
<th>TF Follow-up</th>
<th>IF Baseline</th>
<th>IF Post-therapy</th>
<th>IF Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Response</td>
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<td>17</td>
<td>18</td>
<td>27</td>
<td>16</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Semantic</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Phonological</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Mixed</td>
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<td>1</td>
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</tr>
<tr>
<td>Total errors</td>
<td>30</td>
<td>21</td>
<td>24</td>
<td>30</td>
<td>25</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

5.4.2 Summary of individual Error Analysis

From the individual analyses, it is not possible to determine if either type of therapy was more effective in reducing the nature of errors produced in naming. Across all
participants, there was a highly mixed pattern of error type reduction across both therapies and time points.

The Item Focused therapy did reduce the number of no response errors immediately after therapy made by participants consistently producing the error type at baseline (GH, AA and RW). No such consistent effect was evident for semantic or phonological errors for the relevant participants. At follow-up, there was also no clear effect in reducing any error type. For the Task Focused therapy, the same pattern of results emerged; no response errors reduced immediately after therapy in the relevant participants (GH, AA and RW) but with no consistent effect upon semantic or phonological errors. At follow-up, there was again no clear pattern in error type reduction.
Chapter 6

Discussion

6.1 Research Aim

The primary research aim of this study was to determine the relative effects of an Item Focused (multimodal) therapy compared to a Task Focused (unimodal) therapy upon naming accuracy, immediately after therapy and at 1-month follow-up. It was hypothesised that:

1. Immediate gains in the targeted impairment of naming would be greater for the Item focused than the Task focused therapy, and,

2. Immediate gains would be more effectively maintained for the Item focused than the Task focused therapy – irrespective of the magnitude of the immediate gain.

6.1.1 Naming

At a group level, there was no significant interaction between treatment type and post-testing time point. Individual analysis suggests that only 1 participant (BR) demonstrated a significant difference between the 2 therapies, at both post therapy time points; he demonstrated significantly improved naming accuracy after the Task Focused therapy immediately after therapy but with greater performance at 1 month following the Item Focused therapy. Findings then aren’t as expected and it cannot be concluded that the IF therapy results in greater gains, either immediately after therapy or at follow-up.).

Although nothing conclusive can be drawn from BR’s performance, exploring his
cognitive and language profiles may provide some explanatory insights into why he was the only participant to demonstrate a difference between the therapies, and also why he demonstrated greater maintenance after the IF therapy (as hypothesised). BR’s language and cognitive profile suggested a broad based impairment across semantics, orthography and phonology (although performance in immediate word recall was a relative strength). It may be expected that participants with widespread deficits may demonstrate positive responses to any therapy due to the scope for improvement. BR’s profile was also similar to those of participants RW and GH. Yet, RW and GH did not share BR’s difference between therapy and time post testing. It may be that, unlike RW and GH, BR’s substantially greater performance in reading and spelling demonstrates a relative preservation of the interactions between the domains. It may be that BR benefited from repeated activation of phonology through the TF therapy immediately after therapy (as did RW and GH), but his relatively preserved orthographic skills (e.g. interactions between semantics, phonology and orthography in reading and spelling) enabled a more positive response to the multimodal IF therapy – a treatment intending to encourage deeper processing through improvement in both the domains and the *interactions* between domains. Some retained ability in the interactions between the domains allows for ‘boosting’ of impaired performance via activation of alternative routes with shared representations and connections. In summary, BR was a participant likely to show a positive response to any therapy due to his deficit severity but he may have also benefited from some preserved ability between domains.

Despite the results not confirming the hypotheses, there are still encouraging findings. Firstly, participants responded well to both therapies. All participants responded
immediately to the IF therapy and only 1 participant (AD) did not respond immediately to the TF therapy. Matching a participant’s profile to therapy is a standard clinical approach and AD was therefore expected to respond well to the TF therapy (a phonologically heavy therapy) as she showed a primary phonological impairment. Yet, interestingly, AD did demonstrate improvement at follow-up. A tentative explanation may be a time effect evident in her repetition: she was the poorest of the group at immediate word repetition but the best at delayed word repetition (contrary to the others in the cohort). Strong performance in a delayed task may indicate relatively preserved ability to reactivate the previously active representations used for a given task. In turn, this reactivation may support greater maintenance, as the same representations are more likely to be activated consistently, thereby promoting greater Representational Economy (activating shared representations to be used in all tasks).

Secondly, as discussed with BR and AD, participants did display maintenance effects for treated items. The results are promising as maintaining any immediate learning effect is problematic in aphasia therapy studies, although they do not support the hypothesis that the IF therapy would improve naming accuracy after an extended time period (i.e. follow-up) since it should encourage deeper processing and a greater degree of Representational Economy. It was not hypothesised that the gains in naming accuracy at follow-up for the IF therapy would be matched by those of the TF therapy. Again, participant’s cognitive and language profiles were explored to seek any explanatory insights. Of the participants who showed maintenance effects for both therapies (EB, AA and GH), there were individual variations. Overall, EB and AA were the least impaired of the cohort and across all domains. It may be that EB
and AA were able to draw upon their relatively preserved representations across the domains to boost response immediately after therapy. Their significant maintenance of treated items following both therapies may again be tentatively linked to their relatively strong performance at a delayed activation task (as with AD). GH is anomalous: he is the most impaired across all domains. It may be that his widespread deficits increased the likelihood of positive response to any therapy. GH displayed levels of impairment across the 3 domains similar to those of RW and BR but the participants did not share similar improvement at both assessment time points for both therapies. As discussed GH maintained both treatment effects, BR maintained the IF therapy treatment effect and RW retained her improvement after the TF therapy. RW’s performance might be explained by her phonological profile; her repetition skills were substantially better than those of GH, therefore she may have been more likely to respond positively to the phonologically dominant TF therapy yet not to the IF therapy long-term as she has relatively damaged interactions between the domains, as discussed earlier with BR).

In summary, the Item and the Task Focused therapy were equally as effective at group level in improving the naming ability of the of participants immediately post-therapy and maintaining performance at follow-up. Individually, the Item Focused therapy resulted in improved naming performance for all participants with only 1 (RW) not maintaining the effect in the long-term. The Task focused therapy had no effect upon naming for 1 participant (AD) immediately after therapy whilst another participant (BR) did not maintain the immediate effect at follow-up. Analysis of individual naming performance at follow-up enabled possible groupings of persons with regards to their linguistic profiles to indicate their likelihood for maintenance; participants
least impaired (AA and EB) and most impaired (GH) across all domains demonstrated greater maintenance of naming improvement across both therapies, whilst participants who demonstrated a greater degree of impairment in a given domain demonstrated difficulty in maintaining immediate effects (RW for IF therapy and BR for TF therapy). Furthermore, individual analyses of error type did not allow conclusion regarding whether one type of therapy was more effective in reducing the nature of errors produced in naming. Across all participants, there was a highly mixed pattern of error type reduction across both therapies and time points. Yet, the findings suggest no response errors were most responsive to change immediately after either naming therapy.

It may that providing any naming therapy may provide a general degree of stimulation to semantic and phonological representations thereby facilitating speech output. Whilst analysis of naming performance indicates some effectiveness of Item Focused therapy, which intends to promote greater Representational Economy compared to the Task focused therapy, it is not possible to state conclusively that the IF therapy is the more effective in improving naming or reducing the types of errors produced.

6.1.2 Repetition, Spelling to Dictation and Reading Aloud

A secondary aim of the study was to examine any effect of an Item Focused and Task Focused therapy upon other language tasks not directly targeted in the therapy so as to explore further the effect of therapy upon Representational Economy as with naming. It was hypothesised:

3. Immediate gains in the non-targeted impairments of repetition, spelling to dictation and reading aloud will be greater for the Item focused than the Task focused therapy.
4. Immediate gains in the non-targeted impairments of repetition, spelling to dictation and reading aloud will be more effectively maintained for the Item focused than the Task focused therapy – irrespective of the magnitude of the immediate gain.

As with naming, there was no significant interaction between treatment type and post-testing time point at a group level for any of the additional language tasks.

Such a finding is unsurprising finding for repetition, as it was the strongest skill for the majority of the cohort prior to therapy (more than half were already near ceiling prior to therapy). Scope for improvement was therefore expected to be minimal and likely only for AD and EB - the participants most impaired in repetition. Comparison of the 2 therapies suggests that EB alone displayed significantly greater accuracy immediately after the TF therapy compared to the IF therapy (despite both participants displaying significant improvement after the IF therapy, which they maintained at follow-up). The reverse pattern was displayed at follow up for both EB and AD after the IF therapy compared to the TF therapy but results did not reach difference significance. Interestingly, both EB and AD showed no significant improvement following the TF therapy (a phonologically heavy therapy) immediately or at follow-up. The IF results may be interpreted as tentative support for the hypothesis that IF therapy promotes greater Representational Economy - as strengthening a shared set of representations would be more likely to be maintained than task specific representations.
For spelling to dictation, AD and EB demonstrated significantly improved accuracy of spelling following the IF therapy when the 2 therapies scores were directly compared immediately after therapy and 1 month later. At an individual level, performance was more varied when comparing treatment effects. For the IF therapy, BR was the only participant showing significant improvement immediately after testing and at follow-up, with EB also showing a long-term improvement. BR was also the only participant to show a significant improvement at immediate post-testing and at follow-up after the TF therapy. BR’s improvement and maintenance after both therapies was not anticipated; his profile suggested that he might respond more effectively to the broad based IF therapy because of his broad based impairments. It may be that BR benefited from repeated activation of orthography through the IF therapy whilst the TF therapy skills fostered repeated activation of phonology. As improvement was only evident after one month, EB’s improvement adds further support that the IF therapy promotes greater Representational Economy and time being required to consolidate the shared cross-domain information provided. Additionally, it may be that as EB was the most high-level participant with relatively mild and equivalent impairments across all domains, she benefited more from the broad based approach of the IF therapy.

The third non-targeted task was reading aloud. One participant (RW) showed greater improvement immediately after the Task Focused therapy when compared to the Item Focused therapy at the same time point. A different participant (BR) displayed the converse pattern at follow up, with significantly greater accuracy following the IF therapy compared to the Task Focused therapy. Individual level performance was again varied at baseline and after each therapy. The IF therapy resulted in improved
performance for GH and EB immediately after therapy which they maintained at follow-up with BR also displayed long-term improvement. For the TF therapy, RW, GH and EB responded immediately after therapy, which was maintained at follow-up by GH and EB. GH and EB demonstrated significant improvement immediately and at follow-up for both therapies (an unexpected finding for GH given his spelling impairment). As with naming, it may be that GH’s severe impairment and EB’s relatively mild impairment across all domains increased their likelihood of positive response to either therapy. BR’s significant follow-up improvement after the IF therapy is perhaps further evidence for the suggestion that the IF therapy promotes greater Representational Economy and time to consolidate the shared, multimodal information.

To summarise the results of the non-targeted language tasks, both the Item and Task Focused therapy were equally as ineffective in improving non-targeted language skills immediately after therapy and after one month. At an individual level however, it is possible to suggest that the non-targeted language tasks did respond more positively to a multimodal, Item Focused therapy. However, further work (i.e. increasing the power of the studies, altering the treatments so they are more distinct) is undoubtedly required to investigate these preliminary findings.

6.1.3 Control Items

Across all four of the language tasks, there was evidence of improvement in control items after both types of therapy. Such significant improvements in control items were not hypothesised for any of the language tasks. For naming, analysis of treated items compared to control items indicated that the improvement in treated items was
attributable to the effects of the therapy. This was not the case however for repetition, spelling to dictation or reading aloud. It is possible therefore to tentatively suggest that the improvement in non-treated (control) items may indicate generalisation (i.e. a treatment effect to untreated items. Generalisation is a primary aim of treatment, as therapists want to effect change that goes beyond the individual treated items thereby maximising the efficiency and effectiveness of any intervention. Finding the occurrence of generalisation in anomia treatment studies is rare. It is possible that the control results reflect a ‘spill over’ effect from repeatedly strengthening shared representations across the domains, thereby supporting the notion of parallel-distributed processing.

Yet, the finding may also be explained by the stability of baselines. The process for item selection may not have been rigorous enough to determine a word a participant was able to consistently and inconsistently retrieve. Furthermore, the process only generated enough items for a single list of control items that were required to be used across both therapies at all assessment time points. Repeated exposure to the control item list may explain some of the improvements in performance across a range of tasks for a number of the participants.

6.1.4 Summary

In summary, participants responded positively to both therapies immediately after therapy, with the majority of participants maintaining performance at follow-up. Whilst the results for naming and the additional tasks indicate some effectiveness of Item Focused therapy compared to the Task Focused therapy, it is not possible to state conclusively that the IF therapy is the more effective. Further work is required to investigate these preliminary findings in terms of therapy promoting greater
Representational Economy. In addition, the results hint at the value of continuing to examine more closely language profiles i.e. levels and domains of impairments to determine immediate and maintained response to therapy.

6.2 Clinical implications

Despite finding no significant difference between the Item Focused and Task Focused therapy, the study does have implications for both the participant and the clinician. Importantly, both therapies were found to improve the naming abilities of all participants in the short-term, and with maintenance effects for 5 of the 6 participants, and a possible suggestion at generalisation – an infrequent finding for therapy studies. The study validates providing impairment based naming therapy for those with a range of deficits at different time points in recovery. It is not possible to address at this stage whether certain language profiles may respond to a particular therapy more positively. Such information would be of great clinical value, and although the data cannot provide this, the results hint at the value of examining more closely language profiles i.e. broad based impairment may respond to any naming therapy irrespective of severity whilst those with more specific impairments may benefit from a particular therapy.

Response to a given therapy requires careful consideration to ensure that improvements are captured. Outcome measures are typically quantified but there is a place for qualitative outcomes. A subjective difference between the two therapies did emerge, however it was not assessed as an explicit outcome measure. All participants, and the clinician, expressed a preference for the Item Focused therapy as the Task Focused was highly monotonous. The Item Focused therapy may also have been preferred as it enabled a participant to have some success during therapy from the
earliest moment due to a range of tasks being involved, whereas the Task Focused therapy compounded the participant’s perception of their expressive difficulties. On the other hand, the Item Focused therapy was a far more time consuming therapy to prepare for the clinician. Resources are under constant strain in the clinical setting. With no clear difference between the two therapies, the clinician has to consider the benefits and consequences of each therapy in line with service demands and participant preference.

6.3 Limitations of Study

There were a number of limitations to the study which would require consideration before any further research is continued. The primary limitation was the power of the study. Eight participants were originally recruited and completed the first phase, however two were unable to finish the study. The small sample size limits the conclusions that can be drawn: for example it is not possible to determine whether the finding of no significant difference between the therapies is because the two therapies were equally as effective or simply that there was not enough power for any true effect to be shown. In addition to a lack of power there were also methodological limitations that affected the certainty of drawing conclusions. The process for item selection may have generated unstable baselines, with words included that had only been failed twice. Item selection generated enough items for one list of control items for use across both therapies at all the time points. Repeated exposure to the control item list may explain the improvements in performance seen across all tasks for a number of the participants. The design of the therapies would also require modification prior to any further study. Reducing the degree of semantic and orthographic information in the Task Focused therapy may create a greater distinction
between the therapies. Furthermore, the multimodal nature of the Item Focused therapy would benefit from being strengthened e.g. including more ‘natural’ therapy with real object stimuli, gesture and drawing. Specific modifications may also boost the Item focused therapy, such as changing the spelling rearrangement to a pure copying task and removal of the semantic feature task as it was clear that, for the more severe participants, such extensive questioning interfered with their processing capability, and subsequent naming.

6.4 Future Directions

The current research study has examined whether impairment based multimodal therapy provided greater gains in the accuracy of naming and additional language tasks (e.g. repetition, reading aloud). Central to the study was the influence of PDP computational modelling in guiding the design of the therapy - the study was linked to a PhD project carrying out computational modelling research focusing on recovery/rehabilitation. The promising results of the study highlight the overall benefit from collaboration between clinicians and computational modellers; deepening understanding of the mechanisms that support recovery/rehabilitation and how these findings can guide treatment (and visa-versa; that is the modelling work has been informed by the clinical work). Future clinical studies continuing to apply PDP modelling within aphasia therapy research would be of great benefit, but more specifically continuing the exploration of multimodal impairment and the concept of representational economy.

Clinical research exploring an item focused therapy upon another language task, such as reading, is a logical progression. Representational economy is more complex in reading given that it involves orthography, semantics and phonology (rather than
semantics and phonology as in naming). Replicating the proposed effects of the item focused therapy seen in naming within reading, would then provide substantial additional support for the idea that therapy attempting to promote the relearning and use of the same sets of representations for related linguistic tasks is most efficient. It is hypothesised that the item focused therapy will improve reading accuracy, and potentially accuracy again on non-targeted language tasks, as the therapy will promote the use of the same sets of representations.

Investigating representational economy and reading therapy in phonological/deep dyslexia post stroke (Crisp and Lambon Ralph (2006) will follow the same premise as for the naming study i.e. the item focused therapy will encourage a range of multimodal input and outputs. However, further investigation concentrating on peripheral dyslexia might provide an opportunity to address the question of how broadly a domain should be targeted in therapy. Letter-by-letter readers are typically impaired within the visual-orthographic system (Lambon Ralph & Patterson, 2008) - a relatively pure deficit within the orthographic domain. With theories of pure alexia falling roughly into 2 groups: 1. Damage to visual word form recognition or 2. As a wider visual processing deficit (Starrfelt, Habekost, & Leff, 2009), therapy to address orthography and / or visual processing might be an interesting progression/addition. Examining how widely a domain may need to be targeted to achieve greatest gain is of substantial clinical relevance. For example, those with Wernicke’s aphasia have a wider acoustic deficit in addition to impaired phonology (Robson et al., submitted). A study investigating the relative gains of a phonological compared to an acoustic therapy may therefore have direct clinical implications for achieving maximal outcome through minimal therapeutic input. Such research would also provide an opportunity to broaden the use of diagnostic techniques within aphasia practice. The
inclusion of EEG imaging may enable investigation of a significant clinical issue: predicting which of 2 therapies is more likely to generate a greater response in a given participant.

The above suggestions are naturally progressions for future research stemming from the aims and findings of this study examining a specific clinical issue: the relative gains of impairment based multimodal therapy. Continued collaboration between PDP modelling and aphasia therapy allows for a multitude of specific clinical questions to be addressed such as the timing of intervention, generalisation, stimuli, therapy tasks and many more besides. The challenge lies in promoting the collaboration to continue achieving greater understanding of the how the brain supports language, how it is damaged and how it can be rehabilitated.
References


128


Meyers, J., & Meyers, K. (1995). *Rey Complex Figure Test and Recognition Trial.* USA: Psychological Assessment Resources Inc.


# Appendix 1

Studies excluded from the review and reason

<table>
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<td>Pre 2000</td>
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<td>Corbett, Jefferies, &amp; Lambon Ralph, 2008; Fridriksson et al., 2007; Saito &amp; Takeda, 2001</td>
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## Appendix 2

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<td>2 Abel, et al., 2007</td>
<td>3 Basso, Marangolo, Piras, &amp; Galluzzi, 2001</td>
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<td>4 Beeson &amp; Egnor, 2006</td>
<td>5 Best &amp; Nickels, 2000</td>
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<td>12 Conroy, Sage, &amp; Ralph, 2009b</td>
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<td>14 Conroy, Sage, &amp; Lambon Ralph, 2009</td>
<td>15 Corsten, Mende, Cholewa, &amp; Huber, 2007</td>
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<td>16 DeDe, Parris, &amp; Waters, 2003</td>
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<td>27 Greenwood, Grassly, Hickin, &amp; Best, 2010</td>
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Appendix 3 - Example of IF therapy (SWPM, SWWM, Semantic Features & naming) for noun ‘arm’
<table>
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<td>art</td>
<td>am</td>
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<tr>
<td>farm</td>
<td>harm</td>
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</table>
Is it a body part?
Is it clothing?
Is it used for lifting?
Is it used for singing?
Is it found in a car?
Is it found on the body?
Can you eat it?
Can you move it?
Is it covered in skin?
Is it made of metal?

What is it?